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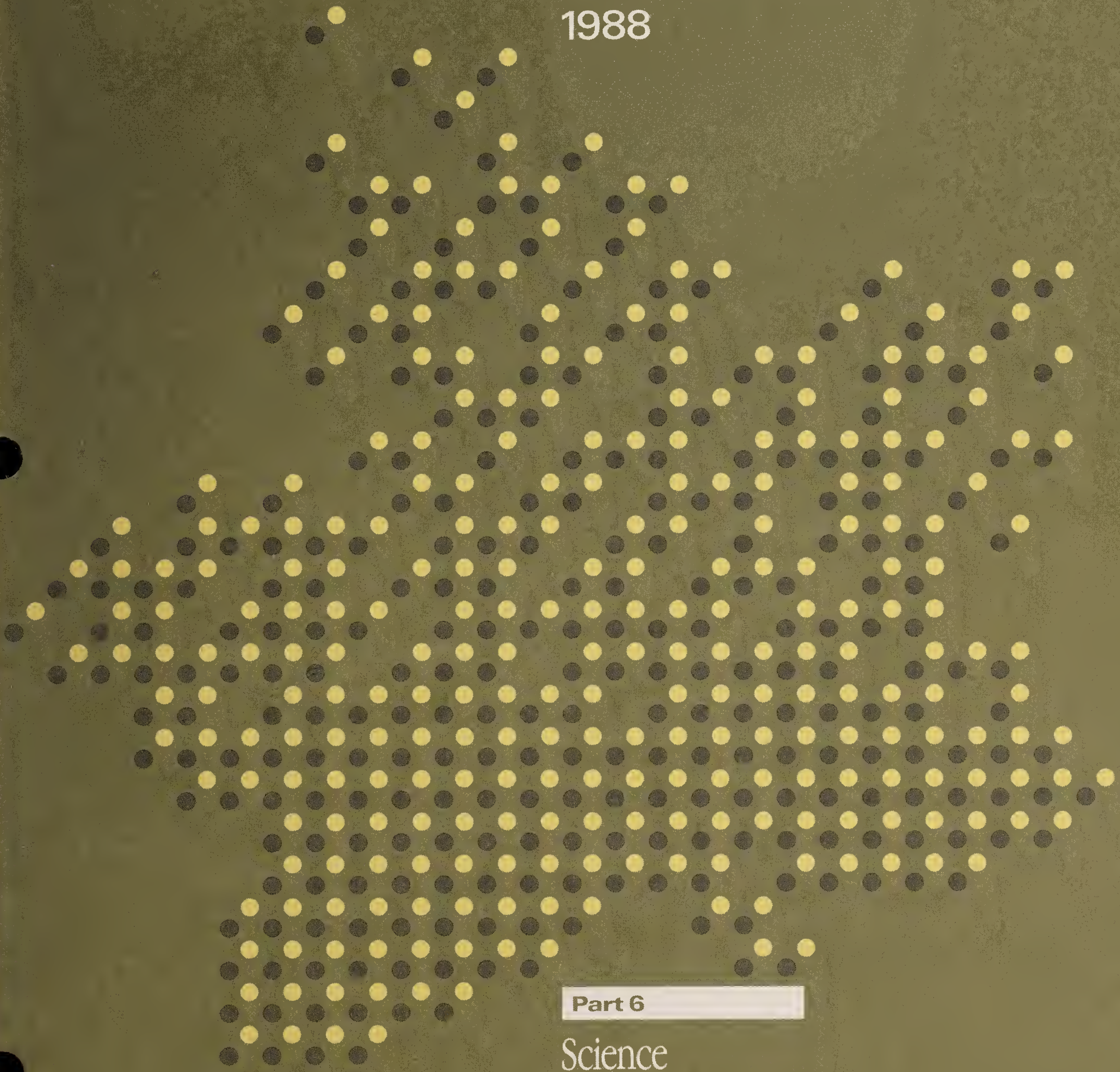
Curriculum Guideline

# Science

## Intermediate and Senior Divisions

1988



**Part 6**

## Science

## Grades 11 and 12, Basic Level

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# Introduction

## The Parts of the Guideline

This document is Part 6 of a fifteen-part curriculum guideline that outlines the science program for the Intermediate and Senior Divisions in Ontario schools and describes the science courses that can be offered (see the list of courses and their course codes in Appendix A). The term *guideline* refers to the entire set of fifteen parts.

This part must be read and implemented in conjunction with Part 1, *Program Outline and Policy*. When implementing the courses that are described in this document, teachers are to incorporate the many policies and features outlined in Part 1, which will enable them to interpret the overall intent and expectations of the Ministry of Education in the science program. The table of contents for Part 1 is given in Appendix B at the end of this document so that the reader may have ready access to the list of chapters and topics therein.

The provincial science program for the Intermediate and Senior Divisions comprises the courses described in Parts 2 to 15. These come under the framework and policy set forth in Part 1. The entire science guideline consists of the following fifteen parts:

Part 1: Program Outline and Policy
Part 2: Science, Grades 7 and 8
Part 3: Science, Grades 9 and 10, General Level
Part 4: Science, Grades 9 and 10, Advanced Level
Part 5: Science, Grades 9 and 10, Basic Level
Part 6: Science, Grades 11 and 12, Basic Level
Part 7: Environmental Science, Grades 10 to 12, General Level
Part 8: Environmental Science, Grades 10 and 12, Advanced Level
Part 9: Applied Biology and Applied Chemistry, Grade 11, General Level
Part 10: Applied Physics and Technological Science, Grade 12, General Level
Part 11: Geology, Grade 12, General and Advanced Levels
Part 12: Biology, Grade 11, Advanced Level, and the OAC
Part 13: Chemistry, Grade 11, Advanced Level, and the OAC
Part 14: Physics, Grade 12, Advanced Level, and the OAC
Part 15: Science in Society, OAC

The chart on the next page indicates the twenty-eight science guideline courses that may be offered in Grades 7 to 12 and at the OAC level.

## Policies and Features That Apply Across the Science Program

Part 1 of the guideline specifies a great number of the policies and features that are to be integrated into the design of the science program in the Intermediate and Senior Divisions. There are too many of them to describe in full in each of Parts 2 to 15, but the following points will give the reader some idea of the scope that is involved. They include:

- information about the science credits that are required for the earning of the Ontario Secondary School Diploma;
- a list of science courses that are prerequisite to other science courses;
- the policy regarding mandatory student activities in the science laboratory;
- a list of the aims of the science curriculum and the various emphases that may be used to blend these aims with scientific content;
- policy governing time allocations for units of study and the order in which core and optional units may be taught;
- stipulations about locally designed units;
- suggestions about preferred routes that students might take through the science program in a secondary school;
- recommendations related to exceptional students, individualized instruction, life-management skills, career awareness, the role and evaluation of language in science courses, and a balanced perspective on the role of both girls and boys in science;
- recommendations on the introduction and handling of sensitive issues;
- specific suggestions about resources for the teaching of science;
- ideas about different modes of delivering science courses, including the co-operative education mode;

## Authorized Science Guideline Courses, Intermediate and Senior Divisions

| | **Basic Level** | **General Level** | **Advanced Level** |
|---|---|---|---|
| Grade 7 | Science | | |
| Grade 8 | Science | | |
| Grade 9 | Science (SNC1B) | Science (SNC1G) | Science (SNC1A) |
| Grade 10 | Science (SNC2B) | Science (SNC2G)<br>Environmental Science (SEN2G) | Science (SNC2A)<br>Environmental Science (SEN2A) |
| Grade 11 | Science (SNC3B) | Applied Biology (SBA3G)<br>Applied Chemistry (SCA3G)<br>Environmental Science (SEN3G) | Biology (SBI3A)<br>Chemistry (SCH3A) |
| Grade 12 | Science (SNC4B) | Environmental Science (SEN4G)<br>Geology (SGE4G)<br>Applied Physics (SPA4G)<br>Technological Science (STE4G) | Environmental Science (SEN4A)<br>Geology (SGE4A)*<br>Physics (SPH4A) |
| OACs | | | Biology (SBI0A)<br>*Prerequisite* – Biology (SBI3A)<br>Chemistry (SCH0A)<br>*Prerequisite* – Chemistry (SCH3A)<br>Physics (SPH0A)<br>*Prerequisite* – Physics (SPH4A)<br>Science in Society (SSO0A)<br>*Prerequisite – One of:*<br>Biology (SBI3A)<br>Chemistry (SCH3A)<br>Environmental Science (SEN4A)<br>Geology (SGE4A)*<br>Physics (SPH4A) |

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*Since the Grade 12 advanced-level geology course described in the guideline (see Part 11) may be taught under the aegis of a geography department as Geology (GGE4A) – note the course-code change – then either Geology (SGE4A) or Geology (GGE4A) may count as a prerequisite to Science in Society (SSO0A).

- policy pertaining to the significant role to be played by measurement and metric units in science courses;
- stipulations related to the treatment of symbols, significant digits, and mathematical problem solving;
- recommendations concerning the roles to be played by calculators and computers in science courses;
- specific directions about safety;
- policy and principles pertaining to the evaluation of student achievement;
- policy regarding differences in the treatment of science courses at the three levels of difficulty;
- many suggestions about implementing the science program.

It cannot be emphasized strongly enough that teachers of science must integrate the policy and recommendations outlined in Part 1 with the teaching of science and cannot simply rely on the course descriptions given in Parts 2 to 15 of the guideline.

## The Science Curriculum Continuum

In the Senior Division at the basic level, students should be provided with a further development of the mosaic approach used in the Intermediate Division. This may be accomplished through the inclusion of the core unit and most of optional units 1 to 5 in each of the Grade 11 and Grade 12 courses outlined in this document. Students need not take full-credit courses in the specialized disciplines of science, namely, a full year or two of biology, chemistry, physics, or environmental science.

It may, however, be important for some students in basic-level Senior science to approach these courses from the perspective of the science disciplines. In such cases, some schools may wish to offer half-credit Senior basic-level courses in science, each with a special emphasis on chemistry, biology, physics, or environmental science. For example, in Grade 11 the first half-credit could focus on chemistry and the second on biology, and in Grade 12 the first half could deal with environmental or life science and the second half with physics. A careful use of core, optional, and locally designed units makes such an arrangement feasible.

In the planning of the basic-level science program in a school, careful attention needs to be given to the selection of optional units in each of Grades 9 through 12, particularly if it is desirable to delay some optional units for a year or two.

In the Grade 11 and 12 basic-level science courses, teachers will have to be sensitive to the varied needs and abilities of students and adapt the science courses accordingly. This may involve the special tailoring of a unit of study for some students; the provision of remedial work in some units for students with an insufficient background; and a full treatment of each unit of study for other students.

## Credit Requirements at the Basic Level

Two science credits are required among the compulsory credits for the earning of the Ontario Secondary School Diploma, and one science credit is needed for the Certificate of Education. It is strongly recommended that students take the Grade 9 basic-level course first, followed by the Grade 10 course. If a student has not taken Grade 9 or 10 science and later decides to include science in his/her program, he/she may take a Senior basic-level science course without having completed an Intermediate course. However, this procedure is not recommended.

Basic-level science courses may be offered in segments for fractional credit value, but in such programs the core unit in each course must be offered in the first segment.

## Curriculum Emphases

It is recommended that teachers organize each of the courses described in this document around a particular curriculum emphasis or set of emphases. Such emphases give the curriculum a special focus that can be introduced in addition to the content and processes outlined in the courses. This approach is discussed in subsection 3.4, "Curriculum Emphases – Blending Curriculum Aims With Content", of Part 1 of the science guideline. In table 2 of that subsection a list of emphases is given. These emphases will enhance the development of the science courses described in this document. A particular emphasis that is stressed throughout an entire course or for one or more units at a time needs to be highlighted so that it becomes a focal or integrating theme.

## Student Activities

In each unit of study there is a section entitled "Student Activities". This section indicates the *mandatory* laboratory activities required of students. Teachers may substitute *equivalent* activities where appropriate. Those activities that are actually to be performed by students themselves are marked with asterisks. If time and circumstances permit, the teacher should encourage students to do some or all of the unmarked activities as well. However, such activities may be demonstrated by a student or the teacher or may be discussed in conjunction with a textbook, film, computer program, or other learning material used as a resource.

In any event, the scientific concepts and principles related to such unmarked activities and identified in the objectives of the unit of study shall be considered to be part of the prescribed course.

Generally, the best approach to the teaching of science is to ensure that the content develops directly from related student activities. In each unit of study the skills and processes of scientific work should be presented as the central component, from which the subject matter, applications, and implications emerge.

## Safety

Safety awareness must be developed in all science students. Constant attention to accident prevention is to be stressed in all student activities and teacher demonstrations in the laboratory. Section 9, "Safety", in Part 1 of the science guideline contains the following comprehensive subsections:

- Safety in the Laboratory
- Some Recommended Safety Procedures
- Animal Care in Science Courses
- The Safe Use of Plants

In each unit of study, subsection 6, "Safety Considerations", acts as a reminder of some of the safety features that pertain to the unit in question. General reference, however, should constantly be made to the safety section in Part 1. Schools must always remain on the alert in regard to safety and maintain an up-to-date safety-awareness program.

## Sensitive Issues

The curriculum outlined in this science guideline places a distinct emphasis on the science-technology-society connection. For this reason scientific applications and societal implications are mandatory components of each unit of study. In addition, Part 1 of this guideline underlines the need to incorporate morals/values education in science courses. Undoubtedly, this will give rise to the discussion of some sensitive issues.

Such discussions are important. Generally, they should be focused and should provide an open forum for the expression of different viewpoints. In this regard teachers of science are urged to familiarize themselves with section 10, "Values in Science Education", of Part 1 of the guideline and to pay particular attention to the principles to be observed when dealing with sensitive issues in the science curriculum. These principles are mentioned in subsection 10.2 of Part 1.

## Locally Designed Units

Among the optional units in each of the courses described in this document is one entitled "Locally Designed Unit" (LDU). Such a unit is included to allow teachers, at their discretion, to introduce an appropriate new area of science not described in the guideline, to expand on previous units or topics by adding new work, or to use the time allocated to the LDU to extend the time allocations for the core units. (See also Part 1, subsection 5.5.)

## Evaluation of Student Achievement

In each unit of study described in the courses outlined in this document, section 5, "Evaluation of Student Achievement", specifies certain items that must be included in students' term marks (exclusive of formal examinations) when their achievement is evaluated. In most units teachers are required to evaluate students' activities and related laboratory reports. However, the proportion of the mark assigned will vary from one teacher to another. In order that the experimental component of science be emphasized, the overall mark for an entire science course must include at least 15 per cent for the evaluation of student achievement in laboratory skills and reports.

## Cross References

In the descriptions of each unit of study in the courses outlined in this document, cross references are provided in parentheses. These are included to provide some examples of the relationships that exist among the parts of the unit.

# Particular Features of the Grade 11 and 12 Basic-Level Science Courses

## Units of Study and Their Time Allocations

The following charts provide an overview of the units of study in Grades 11 and 12 science at the basic level and indicate the approximate amount of time to be allotted to each unit.

### Science, Grade 11, Basic Level (SNC3B)

| Units of Study | | Time Allocations |
|---|---|---|
| *Core* | | |
| Consumer Chemistry | | 30 h |
| *Optional* | | |
| 1. Applied Chemistry | 20 h | 80 h |
| 2. Forensic Science | 20 h | |
| 3. Outdoor Living | 20 h | |
| 4. Metallurgy | 20 h | |
| 5. Microbiology | 20 h | |
| 6. Locally Designed Units (LDUs) | 20 h | |
| | | 110 h |

### Science, Grade 12, Basic Level (SNC4B)

| Units of Study | | Time Allocations |
|---|---|---|
| *Core* | | |
| The Wise Use of Energy | | 30 h |
| *Optional* | | |
| 1. Physics at Work | 20 h | 80 h |
| 2. Sound | 20 h | |
| 3. Heredity | 20 h | |
| 4. The Changing Environment | 20 h | |
| 5. Photography | 20 h | |
| 6. Locally Designed Units (LDUs) | 20 h | |
| | | 110 h |

## Aims of the Basic-Level Science Program

Science courses at the basic level are to meet the needs, abilities, and interests of the students within a particular school community. For this reason the purpose and meaning of these courses must be made clear to students, and teachers must ensure that the scientific content and processes included in the courses are applicable to students' lives. Courses are to be designed so that they are practical and experimental and so that they provide students with the opportunity to experience success.

Students who take science at the basic level will have the opportunity to develop:

- a feeling of self-worth (e.g., confidence, self-discipline, satisfaction with their achievement);
- work-related skills (e.g., time-management skills, fine-motor skills, communication skills, the abilities to attend to a task and to follow instructions);
- an understanding of societal issues as they relate to science (e.g., genetic engineering, alcohol addiction);
- an awareness of environmental issues (e.g., acid rain, water pollution, waste disposal);
- an appreciation of the role that science plays in their lives (e.g., through medicine, consumer chemistry, astronomy, combustion, first aid);
- the ability to work and communicate with their peers.

The attitudes and skills that students will require in managing their lives, finding success in employment, and assuming social responsibility should form the basis for the curriculum at the basic level. Science is a medium through which these attitudes and skills can be developed and reinforced.

## Design of Local Courses

Basic-level science courses must differ from general- and advanced-level science courses. Since students enrolled in basic-level science courses have very diverse backgrounds in science, their programs must be adapted to suit the needs and experiences of the individual or class and at the same time must provide a scientific emphasis and intellectual challenge. The courses outlined in this document attempt to provide a reasonable balance between direction and flexibility.

Basic-level courses, like all of the Intermediate and Senior Division science courses, are composed of units of study. However, the units of study in these courses are much more flexible and open-ended than are those in other courses. In general- and advanced-level courses all of the objectives are prescribed. In basic-level courses the objectives and certain other components are to be selected from the course descriptions according to the following conditions:

- *At least one-half* of the objectives are to be included from each of the categories – attitudes, skills, and knowledge.
- *At least one-half* of the student activities, including all those marked with an asterisk, are to be included.
- Skill objectives and student activities should be related.
- *At least one-half* of the applications and the societal implications are to be included.
- Where the evaluation of student achievement is directly related to mandatory student activities, such evaluation is also to be included.
- The safety precautions are essential.

Each unit of study should be treated not as a rigid body of knowledge, but as a theme that can be flexibly created to suit students' interests, needs, and abilities. Special adaptations are to be made for exceptional students.

In the overall design of a Grade 11 or 12 basic-level science course, the optional units that are chosen and any locally designed units that are developed should be such that the program gives students a balanced exposure to topics in biology, chemistry, physics, and environmental science.

Each course shall consist of one core unit, which is to be allocated up to thirty hours of class time. At least three additional units are to be selected from optional units 1 to 5. Each of these should be allocated up to about twenty hours. Any remaining time may be used for additional optional units, for locally designed units, or for optional units from an earlier basic-level course that have not been taught previously in the school. It is strongly recommended that at least five units be studied in a given full-credit course. The time spent on any optional unit is limited to about twenty hours to provide for a broad range of units and to prevent boredom caused by overemphasis on any one unit.

## Objectives for Basic-Level Science

When designing the basic-level science program, teachers and curriculum committees are to emphasize general objectives related to attitudes, skills, and knowledge. In this introduction, overall knowledge objectives are not enunciated, since specific knowledge objectives are contained in each theme along with additional specific attitude and skill objectives. All goals, aims, and objectives should focus on students' interests and abilities in order to enrich their present lives and to prepare them for the future.

The attitude and skill objectives, as well as the mastery of subject matter, are essential components of each unit. Students must be given ample time to develop positive attitudes and to experience hands-on activities. The criteria for selecting and developing topics within each unit should be the perceived needs and interests of students, particularly in the areas of attitudes and practical skills.

***Attitudes.*** Students will be encouraged to develop:

- a willingness to accept praise when work is well done;
- an accepting attitude towards constructive criticism that is intended to help them learn and mature;
- a willingness to accept responsibility;
- a respect for the rights of others;
- a concern for the progress and welfare of their classmates;
- a commitment to the idea that trust and trustworthiness enhance friendships;
- loyalty to self, family, and society;
- a commitment to work well and to prepare with others in the science classroom for the world of work;
- a commitment to recognize their strengths and limitations and to apply their capabilities;
- a concern for the environment;
- an inquisitive attitude towards life and nature;
- an interest in the relationships between science and technology.

***Skills.*** Students will have the opportunity to improve their proficiency in:

- the communication skills of listening, speaking, reading, writing, and viewing;
- performing arithmetic operations, such as adding, subtracting, multiplying, dividing, and estimating;
- safely using simple apparatus such as measuring devices (linear, temperature, volume, mass), microscopes, heating equipment, and simple dissection equipment;
- following verbal and written instructions;
- following directions in sequence when performing experiments;
- the process skills of science, such as observing, classifying, interpreting, inferring, predicting, summarizing, and evaluating;

- recording meaningful data in notes, charts, diagrams, and graphs;
- preparing and writing up experiments;
- managing their time during class and developing positive study habits;
- maintaining a notebook and using it as a reference source;
- using information sources such as libraries, computers, and magazines.

***Knowledge.*** While the science content is important in teaching skills and influencing attitudes, it should not be given as high a priority in basic-level courses as in advanced- and general-level courses. This approach is reflected in the flexibility allowed in the selection of subject matter in each of the units described in this document. While subject matter should not be treated with undue rigour, it is, nevertheless, important that students in basic-level science courses realize that they are developing intellectually and gaining a good understanding of scientific phenomena.

The development of good language usage should be an important feature of basic-level science. However, the scientific vocabulary and expressions implied in the knowledge objectives may require some simplification so that they are appropriate to the students in the course.

The method of instruction must reflect the unique needs of students studying at the basic level. It is essential for the teacher to be aware of each student's adolescent characteristics and behaviour, to create a feeling of acceptance and encouragement, and to provide and maintain meaningful routines. Numerous opportunities should be provided for students to participate in activities of various kinds to match their varied learning styles.

## Evaluation of Student Achievement

As part of the positive climate within the classroom, the evaluation of student achievement must nurture self-worth and a sense of accomplishment. While the evaluation of objectives is important for the completion of each unit, consideration must be given to the progress and development of individual students throughout the whole course. Personal skills and attitudes in such areas as co-operation, time management, manners, and effort must be included in the evaluation plan. Frequent and immediate feedback will promote in students a feeling of achievement and an improved self-image, and this will foster positive attitudes towards the teacher, the subject, and the course.

Teachers may evaluate student achievement by using a variety of methods such as the following:

- considering students as individuals who are achieving at their own level and assessing their personal progress through an examination of their notebooks, oral reporting during practical work, daily work, and term projects
- giving tests before and after a unit of study
- basing assessment on individual contracts when there is a wide range of abilities in a single class
- grading a student's contribution to the class when he/she submits or reports on newspaper articles and other material brought in from outside the classroom as extra work
- restricting examinations and other summative testing to comparatively short portions of a course and using a wide range of evaluation techniques

For further suggestions on evaluation see section 14 of Part 1 of this guideline.

# Science, Grade 11, Basic Level (SNC3B)

**Core Unit**

Consumer Chemistry

*(Up to 30 hours)*

**Optional Units**

Applied Chemistry
Forensic Science
Outdoor Living
Metallurgy
Microbiology
Locally Designed Units (LDUs)

*(About 80 hours)*

Core Unit

# Consumer Chemistry

*Time: Up to 30 hours*

Through blending ingredients and observing the chemical reactions that occur, students will be introduced to the scientific principles used to control the production of many common consumer products. An introduction to product testing is given, and the regulations governing product labelling are examined.

This unit may be divided into topics such as the following:

- Hard and soft water
- Making soap
- Emulsions and emulsifiers
- Consumer-product testing
- Product safety

## 1. Objectives

At least one-half of the objectives from each of the following categories are to be selected.

***Attitudes.*** Students will be encouraged to develop:

a) a concern for the value they obtain for their consumer dollars (3f, 4a);
b) a co-operative attitude when working with others and handling chemicals;
c) an appreciation for the role played by science and technology in the production of common substances (3b-3e);
d) a concern about the use of processed cosmetics and foods (3a);
e) a respect for the role played by government and consumer agencies in regulating consumer products and in providing consumers with information to help them make wise purchases (3g);
f) confidence in their ability to organize and present their findings in the form of a written or an oral report or project (2h).

***Skills.*** Students will have the opportunity to develop skill in:

a) accurately and carefully using laboratory equipment such as the triple beam balance, graduated cylinder, and pipette (2c-2f);
b) making careful observations that could be recorded by means of tables or graphs and communicating the data in oral or written form (2e, 2f);
c) accurately following a sequence of oral and written instructions;
d) heating and blending aqueous and non-aqueous ingredients (2c);
e) controlling variables to facilitate the making of comparisons (2e).

***Knowledge.*** Students will be expected to:

a) explain the need to use equal masses or volumes when comparing the costs of products (2e);
b) define the terms *hard water* and *soft water* (2a);
c) explain the process of soapmaking, naming the reactants and products (2c);
d) describe soap scum and explain how it is formed (2a);
e) state the differences between fats and oils;
f) explain the following terms: immiscible, miscible, suspension, emulsion, emulsifier (2b, 2c);
g) state the differences between an emulsion and a solution (2b);
h) explain the function of cosmetic and food additives such as preservatives, antioxidants, and stabilizers (2g);
i) match a list of common food additives with the common types of food additives (2g);
j) list three regulations that apply to cosmetic and food-product labelling in Canada (2h);
k) list three properties of proteins that are used in food production (2d).

## 2. Student Activities

Students are to:

*a) carry out an experiment to compare distilled water, hard water, and a sample of tap water for the presence of dissolved minerals;
b) carry out experiments to demonstrate the meaning of the terms *miscible*, *immiscible*, *emulsion*, and *emulsifier*, using materials such as water, ethyl alcohol, cooking oil, and soap;
*c) (i) observe a demonstration of the use of fats and oils to produce a soap *or* (ii) investigate the blending of immiscible liquids and the role of an emulsifier by preparing a cosmetic such as hand cream or food products such as mayonnaise or hollandaise sauce (5b, 6e, 6g);

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*See the subsection entitled "Student Activities" on page 5.

d) investigate some of the properties of proteins used in the preparation of products such as cheese, casein glue, yogurt, and custard (6h, 8c);
e) separate the components of similar products, such as vegetable beef soup, "chunky" beef soup, canned beef stew, and frozen beef pie, and compare the amount of each component in each product and the relative costs of the products (8a);
*f) perform a series of experiments related to consumer-product testing, such as the following: (i) a comparison of a number of bar soaps or shampoos using the criteria of pH, foaming ability, emulsifying action on cooking oil, and reaction to hard water; (ii) a comparison of a number of cold creams, using the criteria of pH, cleansing ability, miscibility with water and grease; and then prepare a written or an oral report comparing the manufacturers' claims for the products tested. Where feasible, students should include in the report a determination, based on the experiments, of whether the manufacturers' claims are reasonable and obtainable; a comparison of the costs of the different products and a ranking of the products in the order of performance, cost, and best value; a summary of the results in chart form; and an evaluation and criticism of the testing procedure;
g) make a collection of food and cosmetic labels and list the common cosmetic and food preservatives;
h) conduct an investigation, in the form of a project, of an area related to the production of a food or cosmetic product (8e, 8f).

## 3. Applications

a) Analyses of the ingredients of cosmetic and food products are done in the quality-control laboratories of manufacturers to ensure the maintenance of product standards.
b) Fats and oils are used extensively as ingredients in the food and cosmetics industries.
c) Glycerine is a by-product of soap manufacturing and is used in the production of explosives, antifreeze, cosmetics, and cough syrups.
d) Emulsifying agents are used in the blending and stabilization of immiscible substances in the production of creams, ointments, sauces, paints, and oils.
e) The properties of proteins are used to control product texture and the binding of components such as solids in fruit and vegetable juices.
f) The listing of ingredients and food grades on labels provides a means of comparing brands and identifying additives.
g) Effective analysis, by government and independent agencies, of product ingredients, performance, and advertising claims prevents fraud and the marketing of dangerous consumer products.

## 4. Societal Implications

a) The evaluation of products by consumer and government agencies aids in protecting consumers and promotes selective and thrifty consumer buying.
b) The reaction of soap with the calcium, magnesium, and iron found in hard water produces a scum. This reaction, which inhibits the cleaning action of soap, led to the development of a cleaning substitute, the modern detergent.
c) The breaking-down of emulsions permits the separation of suspended wastes in chemical and sewage-treatment plants.
d) Labelling standards ensure the exclusion or limited use of substances identified as harmful or of doubtful value and allow the consumer to identify the presence of allergenic additives.
e) The production of protein from petroleum through the use of microbes provides an efficient means of helping to meet the worldwide demand for protein.

## 5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on students':

a) use of charts in recording data;
b) preparation of products such as hand cream, mayonnaise, or hollandaise sauce;
c) manipulation and use of laboratory equipment such as the triple beam balance, graduated cylinder, and pipette;
d) oral or written reports;
e) participation in practical work.

## 6. Some Safety Considerations

a) Students should be cautioned that some of the chemicals used in the experiments may cause allergic reactions.
b) Specific glassware and equipment should be reserved for the preparation of cosmetics or foods, and these should not be used as general laboratory apparatus.
c) The ingredients used in the preparation of food and cosmetics should be of a grade permitted for this use.
d) Students should be cautioned about the care required in working with hot oils, fats, and lye and in blending aqueous and non-aqueous solutions that have been heated. They should use protective eyewear when handling these materials.
e) If alcohol is employed to facilitate soapmaking, hot plates or water baths should be used for heating.
f) Student-made cosmetics should not be applied to eyelids, lashes, or the area immediately around the eyes.
g) Students should be aware of the procedures necessary to control and neutralize a spill of lye or other caustic material.

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*See the subsection entitled "Student Activities" on page 5.

h) Clean equipment is required for cheesemaking. Students should be cautioned about the possibility of spoilage during ripening. Samples that have an offensive odour or appear spoiled should not be tested.
i) The pH of soaps or cosmetics should be checked before these products are used.
j) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

## 7. Possible Extensions

Some students might:

a) test several foods for the presence of starch, glucose, fat, and protein and determine their mineral and moisture contents;
b) investigate the coalescing of fat in the production of butter;
c) prepare soaps from a variety of fats, oils, and alkalis and compare their properties;
d) investigate the pioneer method of obtaining alkali from wood ash and compare this with the method of determining the mineral content of foods by ashing;
e) investigate regulations regarding the types of additives that may be used in cosmetics and their labelling;
f) investigate the part played in baking by proteins found in egg whites, milk, cartilage, and wheat;
g) design and carry out a series of experiments to compare the qualities of various brands of a consumer product, such as laundry detergents, fabric softeners, toothpastes, or glass cleaners.

## 8. Some Teaching Suggestions

a) The separation of the solid components of stews, frozen meat pies, and so on may be carried out in a sieve by flushing with water. The wet mass of each type of solid can be compared after separation.
b) The availability of a large selection of empty food packages in the classroom allows students to become aware of most of the interesting food additives and promotes the idea that science is related to everyday experiences.
c) A film on the commercial methods employed in cheesemaking can be used as a preview to student activity 2d.
d) Although Canadian law does not require manufacturers to place a list of ingredients on their cosmetic packages, some cosmetics manufacturers do. Students should be encouraged to start collecting labels and gathering information at the beginning of the unit. Samples of previous students' work can be used to help them organize their own work and to stimulate interest and confidence.
e) Students can be provided with a list of possible projects, and additional topics of interest can be discussed. A discussion of the merits of, and possible problems related to, each topic will help them to identify the steps they must take in completing the project.
f) Projects might include a limited number of experiments, such as the comparison of food colourings used in small sugar-coated chocolate candies or the production of a lipstick sample.
g) The following are examples of new topics and units that can be developed from the topics in this unit:

| Topics in This Unit | Additional Topics or Units |
|---|---|
| Hard and soft water | Properties of water |
| Making soap | Organic chemistry |
| Emulsions and emulsifiers | Detergents |
| | Paints |
| | Dairy products |
| Consumer-product testing | Fibres and fabrics |
| | Plastics |
| Product safety | Government regulations |
| | Preserving food |
| | Microbiology |
| | Dangerous chemicals |

Optional Unit 1

# Applied Chemistry

*Time: About 20 hours*

This unit is designed to introduce students to the world of manufactured chemicals – from their origins as raw materials to their production and eventual disposal. Students will note how science and technology influence these stages and will also be alerted to some of the choices that society must face in dealing with various materials. Science, technology, and society must work together to maximize the benefits of manufactured chemicals and minimize the problems caused by our demand for them.

This unit may be subdivided into the following topics:

- Papermaking
- Distillation
- Catalysts
- Synthetics
- Recycling

## 1. Objectives

At least one-half of the objectives from each of the following categories are to be selected.

***Attitudes.*** Students will be encouraged to develop:

a) a respect for the properties of the chemicals and materials used in the laboratory;
b) a curiosity about industrial processes that are expansions of small-scale experiments done in the laboratory (3b, 3d);
c) a respect for the economic value of the petrochemical industry to Ontario and Canada (4c);
d) an appreciation that science and technology provide a means of converting raw materials into useful forms (3a, 3b, 3d, 3f-3h);
e) a respect for the attributes of fossil fuels and the raw materials that are used to make petrochemicals and a realization that such substances are non-renewable resources (4g);
f) critical-mindedness towards a growing number of manufactured chemicals that are in use today that present a hazard to health, have an unknown effect on the environment, and may be difficult to dispose of safely (4d, 4f).

***Skills.*** Students will have the opportunity to develop skill in:

a) using laboratory equipment to investigate the properties of substances;
b) handling chemicals in a safe and appropriate manner;
c) accurately following a sequence of oral and written instructions;
d) making careful observations and accurately communicating these in oral or written form;
e) discussing issues and forming tentative opinions based on factual material presented in class (2d, 2h).

***Knowledge.*** Students will be expected to:

a) explain in simple terms how paper is produced (2a);
b) define or correctly use the following terms: molecule, compound, organic, hydrocarbon;
c) list three types of organic compounds and state one example of each;
d) explain in simple terms the process of distillation (2c);
e) define the following terms: fraction, distillate (2d);
f) list and give the use of three fractions of crude oil (2d);
g) define or correctly use the term *catalyst* and state two common uses of catalysts (2e);
h) define or correctly use the terms *fuel*, *petrochemical*, and *polymer* and state two examples of each;
i) explain the meaning of the following terms: synthesis, synthetic, decompose, biodegradable, recycle;
j) list three materials that are commonly recycled (2h);
k) explain how local household garbage is processed (2h).

## 2. Student Activities

Students are to:

*a) prepare paper from cotton or linen fibres, wood shavings, coarse sawdust, or shavings from a pencil sharpener (6e);
*b) (i) observe a demonstration of the cutting and bending of glass tubing to construct apparatus for the distillation of wood and its liquid product and (ii) destructively distil some wooden splints, collect the products, and determine the approximate number of components in the liquid product by distillation (6a-6d, 6i, 8b);

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*See the subsection entitled "Student Activities" on page 5.

c) separate water and isopropanol from a mixture of, for example, water, isopropanol, sand, and food colouring (6d, 6g);
d) investigate the fractional distillation of crude oil into its major fractions and discuss their use in the production of fuels and petrochemicals (6d, 6e, 6g-6i, 8c, 8d);
e) investigate the action and characteristics of a catalyst, for example, the effect of manganese dioxide on the decomposition of hydrogen peroxide (6e, 8f);
f) carry out an experiment to illustrate the synthesis of a polymer such as Thiokol, a polysulphide (6e-6g, 6i, 8d);
g) compare the properties of natural and synthetic rubber and summarize the results in a chart (6e, 8h);
h) investigate a sample of daily solid household garbage and classify the types of wastes, determine if each can be recycled, and determine what is done with each type by local disposal agencies (8g).

## 3. Applications

a) The pulp-and-paper industry is extremely important to the economy of Ontario.
b) The distillation of organic substances such as wood and coal yields such organic compounds as ethanol and acetic acid, as well as many other compounds that are made into cosmetics, dyes, and medicines.
c) Many pieces of scientific apparatus are made from glass.
d) Hobbies such as glassblowing and the working of designs in stained glass have wide appeal.
e) Distillation is used industrially to separate and to purify substances such as alcoholic beverages, perfumes, and edible oils.
f) Gasoline and other fuels are mixtures of hydrocarbons.
g) Plastics, resins, synthetic rubber, carbon black, and synthetic fibres represent a high proportion of the petrochemicals produced.
h) Enzymes are catalysts that control biochemical reactions.
i) Catalysts are used in a large number of industrial processes, from the synthesis of ammonia to the production of nitric acid.

## 4. Societal Implications

a) Many synthetic substances replaced natural ones as they became scarce, thus affecting our lifestyles.
b) The demand for synthetics such as food supplements, farm chemicals, pharmaceuticals, and cosmetics has created a demand for highly trained personnel to conduct research into ways of producing new substances to meet continuing demands.
c) The petrochemical industry has contributed to the wealth of Ontario and has provided employment in areas such as Sarnia.
d) The production and use of many organic chemicals can cause harm to people and the environment. Society must work with scientists and industrialists to set limits on these risks and also help in cleaning up the dangerous materials that have been released.
e) Attempts are being made to synthesize the active compounds in naturally occurring folk and native remedies.
f) Many manufactured materials, such as polymers and pesticides, are not biodegradable and create disposal problems. Many of these substances persist and build up in the food chain.
g) Over 80 per cent of the crude oil produced is used for energy purposes. Alternative energy sources must be found if we are to conserve this resource.
h) The development of catalysts made possible the production of petrochemicals by reactions that would otherwise be too slow to be economically feasible.

## 5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on such activities as students':

a) manipulation and use of laboratory equipment;
b) preparation of paper from simple materials;
c) separation of fractions by distillation;
d) care and effort in participating in practical work, following instructions, working safely, and completing tasks;
e) discussing, either orally or in writing, the contributions and hazards associated with the petrochemical industry.

## 6. Safety Considerations

a) Students should be cautioned that hot glass is not easily recognized. Hot items should be placed on a wire screen until cool.
b) The ends of all glass tubing should be fire-polished.
c) When glass tubing is inserted into rubber stoppers, the tube and the inside of the stopper should be lubricated with dishwashing detergent or glycerine. Safety gloves should be worn for the insertion of the glass.
d) Students should be warned to remove the end of the condenser from the cool distillate before removing the heat source from the flask, as the distillate could be drawn up and could crack the hot glass.
e) Students should be cautioned about the potentially hazardous properties of any chemicals being used.
f) Care should be exerted when Thiokol is squeezed out, as trapped liquid may squirt out. Tongs should be used.

g) Students should wash their hands after handling organic chemicals.
h) The laboratory distillation of crude oil or petroleum fractions should be demonstrated with proper precautions rather than carried out as a class experiment. Methanol should not be distilled.
i) Experiments producing potentially noxious fumes should be performed in a fume hood.
j) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

## 7. Possible Extensions

Some students might:

a) make other glass items (e.g., eye droppers, capillary tubing);
b) demonstrate the steam distillation of a tar-sands sample or of cloves or orange rind to obtain their essential oils;
c) identify the number of manufactured chemicals in the classroom;
d) demonstrate the catalytic effect of cigarette ash on burning sugar or the enzyme action of saliva on starch;
e) demonstrate the synthesis of nylon using the "nylon rope trick";
f) test samples of different plastic items and compare them in terms of strength, flexibility, flotation in water, heat resistance, and combustion characteristics (*note*: plastic samples should be burned only in a fume hood);
g) visit a recycling depot, a company that uses recycled material, a petrochemical facility, or a waste-disposal plant.

## 8. Some Teaching Suggestions

a) Models, samples, and a variety of audio-visual and printed material should be used to supplement the activities.
b) The techniques of working with glass should be demonstrated.
c) The student fractions can be collected and combined to use as examples in a discussion of the processes used in industry to produce a tar (similar to that used to provide a base on wooden cross-country skis), methanol, acetic acid, acetone, carbon dioxide, and methane.
d) Films, posters, and pamphlets can usually be obtained by writing petroleum or petrochemical companies.
e) Students should be encouraged to suggest the priorities that should determine the disposition of petroleum resources. Attitudes towards exportation and economic and market considerations should be discussed.
f) The role of catalysts in petrochemical manufacturing should be introduced.
g) The obstacles to recycling and the problems connected with landfill sites, incineration, and the disposal of chemical wastes should be discussed.
h) A good source of natural and synthetic rubber is the rubber tubing used in the laboratory. If ultraviolet light degradation of rubber is studied, samples must be exposed to sunlight for a one-month period.
i) There are a number of Canadian scientific firsts; the following are some examples. Acetylene was first produced on a large scale in Canada. Kerosene was first developed in Canada. The first commercial oil well was located in Oil Springs, Ontario. Other Canadian scientific firsts can be investigated and related to industrial applications of science (e.g., tar-sand technology, atomic energy, space research).
j) The following are examples of new topics and units that can be developed from the topics in this unit:

| Topics in This Unit | Additional Topics or Units |
|---|---|
| Papermaking | Fibres and fabrics |
| Distillation | The distilling industry<br>Perfumes |
| Catalysts | Pollution control<br>Digestion |
| Synthetics | Cosmetics and food<br>Butter and margarine |
| Recycling | Community programs<br>Resources |

Optional Unit 2

# Forensic Science

*Time: About 20 hours*

Forensic science deals with the relation and application of scientific data to legal problems. Often the legal problems involve police investigations of suspected crimes. The Crown employs scientists and technicians to analyse materials, using the latest in scientific technology. A great deal of this work involves gathering data and using the data to solve problems or answer questions.

In this unit the emphasis is on the importance of gathering information through scientific techniques, as well as using the information to answer questions.

This unit may be divided into topics such as the following:

- A hypothetical crime
- Fingerprinting
- Fibre analysis
- Soils
- Forgery
- Casts

## 1. Objectives

At least one-half of the objectives from each of the following categories are to be selected.

***Attitudes.*** Students will be encouraged to develop:

a) a respect for the rights and responsibilities of others (4a);
b) a commitment to co-operate and share information (4b);
c) an interest in the numerous career possibilities in an important public service;
d) a respect for law enforcement (4b).

***Skills.*** Students will have the opportunity to develop skill in:

a) observing and differentiating characteristics in designs (2b);
b) summarizing information from a police crime report (2a);
c) classifying according to set criteria, for example, identifying fingerprints (2b);
d) lifting fingerprints from hard, smooth surfaces (2b);
e) following laboratory instructions (2a, 2g);
f) using a microscope to observe hair samples (2c);
g) interpreting observations to identify a particular sample (2c);
h) measuring to determine the dimensions of a footprint (2f);
i) making a plaster of Paris cast of a shoe print (2f);
j) preparing an argument to indicate that a suspect is innocent or guilty.

***Knowledge.*** Students will be expected to:

a) describe the type of information that police collect on a crime (2a);
b) describe two characteristics of a licence plate that can be used in solving a crime;
c) identify the main characteristics that are used to classify fingerprints (2b);
d) describe the sequence that should be followed in obtaining a fingerprint (2b);
e) describe the characteristics of several hair samples (2c);
f) describe three ways of differentiating soil samples (2d);
g) describe the water markings and qualities of different writing paper (2e);
h) describe the characteristics of different handwriting samples (2e);
i) describe the type of information provided by a shoe print (2f);
j) describe the procedure police use when making a plaster cast (2f);
k) outline how an argument is prepared to indicate that a suspect is innocent or guilty.

## 2. Student Activities

Students are to:

a) participate in a class discussion on the difficulties that witnesses can have in positively identifying a suspect or in recalling the circumstances of a crime (8a);
*b) obtain fingerprints from various sources in the laboratory and classify a set of fingerprints into their main categories (5c, 6a, 6c, 8b);
c) describe the characteristics of a human hair observed under the microscope (8c);

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*See the subsection entitled "Student Activities" on page 5.

*d) use laboratory equipment, including the microscope, to determine characteristics such as the colour, particle size, and pH of several soil samples and use this information to form a hypothesis about a soil sample taken from a suspect's footwear (5d, 8d);
e) attempt to identify a forged document by analysing the handwriting and by chromatographic analysis of ink samples (6b, 8e);
f) prepare a plaster of Paris cast of a shoe print (6b, 8f);
g) participate in a discussion to consider why individuals become criminals and to suggest ways to prevent crime;
*h) collect and analyse samples of evidence from the scene of a hypothetical crime in order to determine the guilt or innocence of a suspect (5b).

## 3. Applications

a) Forensic science frequently discovers new identification techniques for a particular drug or chemical.
b) Forensic science has increased our knowledge about the human body.
c) Hair-fibre analysis is being used to identify various forms of cancer, dietary deficiencies, poisons, and heavy metal concentrations in the body.

## 4. Societal Implications

a) Technological advances have made more sophisticated equipment available to both the criminal and the police.
b) Solving a crime requires skills that are associated with science, such as gathering data, interpreting information, making hypotheses, and drawing conclusions. These skills are also required by jurors when presented with evidence in a court of law.

## 5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on such activities as students':

a) reports on their investigations and projects;
b) summaries or reports of an alleged crime;
c) ability to lift a fingerprint from a hard, smooth surface;
d) ability to determine the pH of a soil sample.

## 6. Safety Considerations

a) A well-ventilated room or fume hood should be used during fingerprinting if ammonium hydroxide is used.
b) Students should use appropriate eyewear and gloves when handling chemicals.
c) Students should not handle solid iodine crystals.
d) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

## 7. Possible Extensions

Some students might:

a) determine whether characteristics of hair fibre differ depending on factors such as sex, age, or tinting;
b) compare tire tracks on different surfaces;
c) determine how museums make casts of fossilized bones;
d) fingerprint several teachers in the school;
e) analyse the components of garden soil;
f) compare the fibres from different types of material.

## 8. Some Teaching Suggestions

a) This unit can be introduced by presenting a hypothetical crime to the class and discussing what type of information is needed to solve it. An example might be a situation in which a laboratory has been burglarized, and a suspect arrested. The police report indicates that an evening stroller observed the suspect sitting in a car with Ontario licence plates at the rear of the building prior to the break-in. A ransom note was left behind. Students can be asked to determine what further information is required to identify the guilty party. They can investigate how licence plates are used to assist in solving crimes and can go to the parking lot to record the characteristics of Ontario licence plates.

Another case that can be discussed is a hit-and-run situation in which it is necessary to identify the driver. A situation can be staged in which an irate student from another class storms into the laboratory and immediately runs out. The students can be asked to identify the student so that the office can be notified. This will reveal the problems in recognizing a suspect in a police line-up or remembering a suspect's characteristics. An alternative would be to flash the same picture at several groups of students and then ask them to list all the objects in the picture.

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*See the subsection entitled "Student Activities" on page 5.

b) Several methods of collecting fingerprints are available. Fingerprint powder (or carbon black or starch), a brush, and clear tape can be used to "lift" prints from hard surfaces. A student's fingerprint may be recorded by means of an inkpad. The student transfers his/her inked finger onto clean, white paper. To raise fingerprints from soft surfaces, the material must first be exposed to concentrated ammonium hydroxide for four minutes and then to iodine crystals. This should be done only as a demonstration.

c) Recording information in a chart will simplify the results for hair-fibre analysis. Such analysis can reveal if the hair is dyed, the cross-sectional shape of hair, the number of scales on a given length of fibre, the appearance of hair fibres, the parts of healthy hair, the differences between animal and human hair, and whether the hair was pulled out or simply fell out.

d) Soil comparisons can be made by obtaining soil samples from a suspect's shoe and a crime site. Students can do an initial comparison of such things as colour, smell, feel, particle size, dampness, and composition. Microscopic examinations of the samples can follow. If time permits, activities such as calculating the percentage of water in the soil or determining soil pH can be included.

e) Students can be given a copy of a ransom note and a copy of a suspect's handwriting. Possible activities include analysing the two documents to determine the quality and watermarks of the paper, similarities in the handwriting, whether identical typewriters were used, and whether or not the suspect's known modus operandi is observable in the ransom note, as well as doing a chromatographic analysis of the inks.

f) A footprint left at the scene of a crime must be compared to the suspect's shoe design. Students can be assigned an area in the schoolyard from which to cast a footprint. Cast prints can also be made from snow impressions.

g) At the end of the unit students can submit a police report on the crime and the suspect. From the findings, the student must judge whether or not the criminal committed the crime.

h) Students can visit the local police station to determine how a crime is investigated.

i) A visit to the provincial court to see judicial procedures would add interest to this unit.

j) The science teacher, in co-operation with the teacher librarian, can plan a book talk or prepare a bibliography of related books (e.g., books on criminal cases or police work or mystery fiction in which the police solve crimes using the procedures students are studying).

k) A dentist can be invited to visit the classroom to discuss the use of dental records in forensic science.

l) The following are examples of new topics and units that can be developed from the topics in this unit:

| Topics in This Unit | Additional Topics or Units |
|---|---|
| A hypothetical crime | Law enforcement<br>Optics<br>Chemicals |
| Fingerprinting | Body functions |
| Fibre analysis | Botany<br>Textiles |
| Soils | Geology<br>Rocks and fossils |
| Forgery | Chromatography |
| Casts | Archaeology |

Optional Unit 3

# Outdoor Living

*Time: About 20 hours*

Many people participate in outdoor activities such as hiking and camping as leisure activities. Students need to have appropriate knowledge and skills to gain maximum benefits from these activities. In this unit students will learn how to prepare for a hiking excursion and the procedures to follow when camping. The problem of how to survive alone in the woods is also considered.

This unit may be divided into topics such as the following:

- Camping and hiking equipment
- Finding the way
- Setting up the campsite
- Weather
- Signs of life
- Survival

## 1. Objectives

At least one-half of the objectives from each of the following categories are to be selected.

***Attitudes.*** Students will be encouraged to develop:

a) a co-operative and trusting working relationship with others;
b) an appreciation of the need for proper planning for an event;
c) a concern for conserving the quality of the environment (4a-4c);
d) an appreciation for the limitations on their ability to survive in an outdoor environment (4d).

***Skills.*** Students will have the opportunity to develop skill in:

a) making observations by using their senses and drawing inferences from their observations;
b) making charts and graphs related to the process of collecting data;
c) making predictions based on compiled data;
d) using an orienteering compass (2b);
e) retrieving information from printed sources (2c, 2e);
f) interpreting information displayed on a graph or map (2b, 2c, 2e);
g) using a map to prepare a route through the city or country (2c).

***Knowledge.*** Students will be expected to:

a) list the items necessary for a successful overnight camping excursion and know why such items are needed (2a);
b) explain how to use an orienteering compass and a map to determine location and possible routes (2b, 2c);
c) list the sequence of activities they should follow in preparing a campsite for the night and describe the technique for starting a fire (2a);
d) interpret the information contained in a daily weather report (2e);
e) list the properties of a good insulating material for outdoor clothing and sleeping bags (2d);
f) describe the habitat of various animals and list several methods by which organisms are able to adapt to their environment (2f);
g) list several ways of increasing the chances of survival in a snowbound car or when lost in the woods (2g, 2h).

## 2. Student Activities

Students are to:

*a) (i) compare the designs of various knapsacks and discuss which provisions are necessary for a camping trip *or* (ii) follow or describe an appropriate procedure for establishing a campsite (5b, 6b-6d, 8a, 8f);
b) investigate and demonstrate ways to use an orienteering compass, particularly for following specific map instructions (6a, 8c);
*c) investigate the information presented on a topographical map and use the reference numbers on a city map to give directions for getting to a previously unknown location from the school (5c, 8d, 8e);

*See the subsection entitled "Student Activities" on page 5.

d) perform an experiment to compare the insulating properties of flannel, goose down, and synthetic insulating material, and record and rank the performance of each material;
e) use weather reports or measure weather data at the school to make up a record of the weather for a one- or two-week period and discuss means of predicting the next day's weather (8g, 8h);
f) (i) conduct a field study of an area, identifying some of the plants and animals present and noting how each is adapted to survive in its habitat, *or* (ii) use the library to find information on wildlife signs in the woods and use this information to identify signs of wildlife on a field trip (8i, 8k, 8l);
g) investigate and demonstrate some techniques for surviving if lost in the bush or stranded in a snowbound car (6c, 6d);
h) perform an experiment to investigate the relationship between snow depth and the inside temperature of a snow drift.

## 3. Applications

a) The use of new, sturdy, lightweight materials makes camping and hiking easier than in the past.
b) Surveying relies heavily on the compass and topographical maps.
c) Modern insulating materials have improved winter clothing.
d) Accurate weather reports are vital to farming and transportation.
e) The correct use of a map often saves time and energy.
f) Airplanes are now required to carry homing devices.
g) Snow ecology and drift control and management are important to keeping roads clear in the winter.

## 4. Societal Implications

a) There is a growing emphasis on heritage parks and nature reserves to maintain high-quality outdoor areas.
b) The action of one organism (e.g., humans) affects the fate of many other organisms in the environment.
c) Humans are the leading cause of forest fires.
d) The finding of a lost hiker causes considerable expense to the public.

## 5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on such activities as students':

a) making and recording of observations;
b) outlining of the steps that must be followed before an outdoor excursion is undertaken;
c) reading of maps and giving of directions.

## 6. Safety Considerations

a) Orienteering exercises should be closely supervised, and students should be instructed in the appropriate procedures to follow if they get lost.
b) Tents should be placed well away from campfires.
c) All drinking water must be certified safe prior to consumption.
d) No natural vegetation (e.g., wild mushrooms) should be consumed unless an experienced guide gives permission.
e) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

## 7. Possible Extensions

Some students might:

a) do a consumer-study report on various tent structures or sleeping bags;
b) investigate the use of stars as a navigational aid;
c) determine the differences between hardwood and softwood;
d) visit a local weather station;
e) determine the regional hunting and fishing restrictions;
f) investigate techniques of winter survival;
g) hike on a local trail (e.g., the Bruce Trail).

## 8. Some Teaching Suggestions

a) Students should be encouraged to bring their own camping equipment to class. Catalogues are an excellent resource to use when doing consumer comparisons.
b) It should be emphasized that a hiking pack should provide easy accessibility, have good balance and light weight, and be comfortable. Various frame structures can be compared by placing identical objects in several designs of knapsack. The length of the shoulder straps on a pack can be varied to determine the correct position for a knapsack. Students can pack it in several ways to identify the best arrangement. Other items that are required on a camping trip, such as a sleeping bag, groundsheet, boots, and a tent, can also be examined and compared.
c) A model compass can be designed and labelled to show the major compass bearings. A map of the classroom or school can be prepared to orient students to the compass bearings. Students can be provided with a sequence of distances and their compass bearings to plot and follow. The effect of metal on compass behaviour can be demonstrated. It is interesting to make a compass with a cork and a magnetized needle floating on water.
d) Drawing school maps will help students to use symbols and will reinforce their linear measurement.

e) Familiar landmarks can be identified on a regional map. A classroom or schoolyard map can be drawn to scale, showing familiar objects by symbols. An object can be hidden somewhere on the school grounds and, using the map and an orienteering compass, students can locate the object. An orienteering course can be set up in the vicinity of the school.

f) Two diagrams can be compared, one showing a well-designed campsite and the other a poorly designed one. The flammability of different tent materials can be tested in the laboratory. The ease with which different sizes of pieces of wood can be ignited can also be investigated.

g) Various types of weather instruments can be examined. Weather equipment (e.g., psychrometer, barometer, wind meter, wind vane) can also be made for the classroom. A weather forecast can be compared with the actual weather experienced. A daily class weather report can be prepared, and the next day's weather predicted.

h) Other less scientific methods of predicting weather can be investigated (e.g., cloud formations, cricket songs, length of caterpillar's fur).

i) Students can visit a conservation area to investigate adaptations in flora and fauna. They might also conduct a capture-recapture population study, identify the depths that various fish species prefer, discuss the peppered-moth study, examine the skeletal remains of several animals, and establish a terrarium or aquarium in the classroom.

j) The fire chief or local forest ranger can be invited to discuss fires and safety with the class.

k) Students should be encouraged to use an identification key to identify a particular animal. Interesting results can be obtained by dissecting owl pellets.

l) Animal prints in the schoolyard can be examined.

m) The following are examples of new topics and units that can be developed from the topics in this unit:

| Topics in This Unit | Additional Topics or Units |
|---|---|
| Camping and hiking equipment | Consumer studies |
| Finding the way | Orienteering<br>Map making |
| Setting up the campsite | Conservation<br>Insulation |
| Weather | Snow studies |
| Signs of life | Animal behaviour |
| Survival | Winter ecology<br>Search-and-rescue teams |

Optional Unit 4

# Metallurgy

*Time: About 20 hours*

In this unit the various stages from ore extraction to the production of the pure metal are considered. Alloy formation is discussed, and students are encouraged to investigate how the properties of materials can be changed through the application of chemical principles. Students also have the opportunity to consider the importance of metallurgy in their lives and some of the problems that must be addressed by society.

This unit may be divided into topics such as the following:

- Minerals
- Metals from ores
- Properties of metals
- Corrosion
- Alloys

## 1. Objectives

At least one-half of the objectives from each of the following categories are to be selected.

***Attitudes.*** Students will be encouraged to develop:

a) interest in the techniques required to grow good crystals (3a);

b) a curiosity about hobbies such as rock collecting, lapidary crafts, and mineralogy (3a);

c) a respect for classification as a means of organizing information so that it is easier to use (3a);

d) a curiosity about the role of science and technology in making possible the conversion of raw materials into useful products with specific properties (3d, 4b-4d).

***Skills.*** Students will have the opportunity to develop skill in:

a) following the techniques involved in crystal growing, including maintenance of cleanliness, filtration, and measurement of mass and volume (2a);
b) using charts to summarize and present data (2e, 2f);
c) making careful observations and communicating these accurately orally or in writing (2b);
d) comparing the properties of various solids and using this information in classifying them (2b, 2c, 2e, 2f);
e) planning the sequence of steps required to carry out a project (2h);
f) using reference material from a wide variety of library sources, such as encyclopedias, magazines, and journals (2h).

***Knowledge.*** Students will be expected to:

a) explain how growing crystals increase in size (2a);
b) name three metals and state one location in Ontario where each metal ore is mined (2e);
c) write a definition for or correctly use each of the terms *ore*, *mineral*, *crystal*, *metal*, and *alloy*, and list one example of each;
d) explain the purpose of roasting an ore and of reducing an ore (2d);
e) describe and explain the process of electrolytic refining of an ore (2d);
f) list and explain the meaning of the following four properties that are common to all metals: lustre, malleability, ductility, and conduction of heat and electricity (2e);
g) explain the concept that alloys are "custom-made" metals and list three common alloys and a characteristic property of each (2b, 2g);
h) write a definition for or correctly use the term *corrosion* and describe three ways in which corrosion can be prevented (2f);
i) describe some benefits to our society of the metallurgical industry;
j) list two problems caused by the metallurgical industry and state the cause and possible solution for each (2h).

## 2. Student Activities

Students are to:

*a) grow a crystal by evaporation, using a saturated solution of alum, chrome alum, copper sulphate, or hypo (5a, 8b);
b) examine samples of minerals, ores, pure metals, crystals, and alloys and classify these samples into groups according to their physical properties and their stated composition (8c);
*c) test the hardness of several minerals by means of a "scratch" test and identify the minerals from a table of hardness (5b);
d) (i) carry out an experiment to show a two-stage separation of a metal from its ore, such as the roasting of copper carbonate and the reduction of the resultant copper oxide with charcoal, *or* (ii) carry out an experiment to show how "blister" copper (98 per cent pure) can be further refined by the electrolytic method (6, 8d, 8e);
e) examine samples of several pure metals, make a list of the physical properties common to most metals, and summarize the data on a chart (8c);
f) carry out an experiment to show the effects of corrosion on iron, steel, and stainless steel and investigate methods of corrosion control, such as paint, petroleum-based coatings, oil, and galvanizing (8f);
g) observe electron micrographs of alloys, such as brass, bronze, solder, or stainless steel; construct a model of an alloy using various sizes of Styrofoam balls; and use the model to explain the properties of the alloy;
h) give an oral or written report describing an environmental problem related to the metallurgical industry and its possible solution.

## 3. Applications

a) The chemical composition and physical properties of metallic solids permit their classification according to their potential use (e.g., as gems, sources of metals).
b) The relative hardness of minerals aids in their identification.
c) An understanding of chemical reactions is used in the refining of an ore into a pure metal.
d) A knowledge of the properties of metals makes it possible to develop blends of metals having a specific set of properties.

## 4. Societal Implications

a) Minerals are an important source of wealth and employment in Ontario and Canada.
b) Iron in the form of steel is one of the basic materials of our economy.
c) Aluminum is produced relatively economically in locations where large amounts of electrical energy are available.
d) Because of the high cost of silver, an alloy of copper and nickel is now being used in coins formerly made of silver.
e) The disposal of wastes from ore-chemical-processing plants is a major societal concern.

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*See the subsection entitled "Student Activities" on page 5.

## 5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on such activities as students':

a) growing of a crystal;
b) use of the scratch test to help identify minerals;
c) care and effort in following instructions, working safely, and completing tasks;
d) oral or written reports based on the laboratory assignments.

## 6. Safety Considerations

a) Appropriate precautions should be taken in the heating of substances.
b) Students should be warned that cooling metals appear to be solid but may be liquid on the inside.
c) Adequate ventilation should be provided when metals are heated in order to remove metallic vapours that may be produced.
d) Students should be cautioned about the nature of reactions involving powdered reactants and the difficulty in recognizing whether powdered solids are hot.
e) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

## 7. Possible Extensions

Some students might:

a) investigate various types of crystals and various methods of growing crystals;
b) construct models of the packing arrangements of atoms in metals;
c) invite a rock collector or lapidarist to talk to the class;
d) identify minerals on the basis of their relative density;
e) carry out an experiment to demonstrate electroplating;
f) demonstrate some interesting properties of alloys such as Wood's metal (low melting point) or nichrome (poor conductor of electricity);
g) locate and plot on a map the areas of acid-rain damage and compare these with the locations of mines and smelters;
h) visit a mine, smelter, or museum of mineralogy.

## 8. Some Teaching Suggestions

a) Each activity or lesson should begin with an introduction centred around a focal point such as a short demonstration or an item of interest. A wide variety of media and printed materials can be used to supplement each activity.
b) Crystal growing requires time and should be started early in the unit.
c) Labels on which chemical symbols are used to show the composition of the ore or alloy should be provided when samples are being classified.
d) Copper(II) carbonate is suitable to illustrate a two-stage process in the refining of an ore. It is easy to obtain, has a different appearance at each stage, and does not produce the odours that a sulphide would.
e) A spatula can be used to make an indentation the size of a small fingernail in a piece of barbecue charcoal or a briquette. The ore to be reduced can be placed in the indentation. A portable propane torch can be used to direct the flame at the ore.
f) Successful corrosion experiments take time to perform. They should be started early in the unit.
g) The following are examples of new topics and units that can be developed from the topics in this unit:

| Topics in This Unit | Additional Topics or Units |
|---|---|
| Minerals | Geology<br>Mining |
| Metals from ores | Steel making<br>Nickel refining |
| Properties of metals | Materials testing |
| Corrosion | Electroplating |
| Alloys | Manufactured chemicals |

Optional Unit 6

# Microbiology

*Time: About 20 hours*

In this unit students will study the problems associated with microbes and the means of minimizing their threat to food in a supermarket. Many ways in which microbes are beneficial and essential to the biosphere will also be considered.

This unit may be divided into topics such as the following:

- Supermarket products
- Rotting and spoilage
- Micro-organisms
- Preserving food
- Micro-organisms and industry

## 1. Objectives

At least one-half of the objectives from each of the following categories are to be selected.

***Attitudes.*** Students will be encouraged to develop:

a) an appreciation of the beneficial uses of microbes (3c, 4b);
b) a respect for the importance of proper hygiene (3b, 4e, 4f);
c) an appreciation of the importance of proper food-preservation techniques (3a);
d) an interest in the role that microbes play in the recycling of the elements found in organic materials (4c).

***Skills.*** Students will have the opportunity to develop skill in:

a) observing by using all of their senses except taste (2a, 2c);
b) classifying according to set criteria (2a, 2d);
c) interpreting experimental results related to food spoilage (2c);
d) following procedures in preparing yogurt, sauerkraut, or bread (2g);
e) reporting results in a clear and concise manner.

***Knowledge.*** Students will be expected to:

a) state three consumer sections in a typical supermarket, such as the produce, dairy, canned-goods, and bakery sections (2a, 2b);
b) describe methods that a supermarket uses to enhance the shelf life of a product (2b);
c) state why dairy products have expiry dates on their packages;
d) classify micro-organisms into various categories (2d);
e) identify suitable habitats for micro-organisms and describe the conditions necessary for their growth and survival (2e);
f) describe how a particular micro-organism reproduces (2d);
g) state three factors that slow down bacterial growth (2e);
h) list and describe common methods of food preservation (e.g., salting, dehydration, cooling, refrigeration, freezing, canning);
i) rank methods of food preservation from most to least effective;
j) outline proper hygiene procedures for handling food;
k) describe three ways in which microbes are beneficial (2f-2h);
l) explain the importance of decomposers in nature and at a sewage-treatment plant (2h).

## 2. Student Activities

Students are to:

a) (i) classify products in a local supermarket according to their origin and record these data on a chart *or* (ii) classify canned goods according to the ingredients listed on their labels (8a, 8b);
b) list the types of packaging used in a supermarket and discuss which types prevent contamination (8a);
*c) (i) observe and report on the spoilage or rotting of a lettuce leaf, orange, or other plant material, *or* (ii) perform and report on an experiment to determine the environmental conditions necessary to promote spoilage or rotting, *or* (iii) describe the steps taken by supermarkets to reduce spoilage in fruit, vegetables, and dairy products (5c, 6b, 6c, 8b, 8c);
d) (i) examine several types of micro-organisms with the aid of a microscope, photomicrographs, or photographs, *or* (ii) group bacterial and other micro-organisms according to their external appearance, *or* (iii) investigate how a typical micro-organism such as yeast reproduces (8d);
e) investigate methods of chemically controlling the growth of micro-organisms; examples can include mould inhibitors,

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*See the subsection entitled "Student Activities" on page 5.

bacterial inhibitors, antioxidants, buffers, stabilizers, coatings, and maturation agents (8i);

f) perform a fermentation experiment (8f);

*g) prepare yogurt, sauerkraut, or bread (5b, 8g);

h) (i) prepare an oral or written report on the action of micro-organisms in a home septic system or a municipal sewage system, *or* (ii) construct a model of a home septic system or a municipal sewage system, *or* (iii) complete a library project on the beneficial uses of micro-organisms (5c).

## 3. Applications

a) Bacteria must not survive in the canning and preserving of fruits and vegetables.
b) Areas in which food is handled are inspected on a monthly basis.
c) Dehydrated food, which is free of micro-organisms, is packed for long camping trips.
d) The spread of microbes can be minimized in the home if appropriate methods of hygiene are observed.
e) Food should not be left for an extended period without refrigeration.
f) Coliform bacteria indicate polluted water.
g) Garbage must be collected on a regular basis to prevent the overdevelopment of micro-organisms.
h) Dairy products are stamped with an expiry date.

## 4. Societal Implications

a) Many elderly persons require annual vaccinations.
b) Bacteria are becoming an important tool in recombinant DNA research.
c) All dwellings require some form of sewage system to remove organic wastes.
d) The high mutation rate of microbes results in their sudden immunity to antibiotics.
e) Numerous people become ill if a food-processing plant or restaurant becomes contaminated.
f) Unsanitary areas tend to foster potential diseases.
g) Compulsory inoculation of young people is essential.
h) The government sets and monitors rigid standards for the food industry.

## 5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on such activities as students':

a) use of charts in recording data;
b) preparation of products such as yogurt, sauerkraut, or bread;
c) oral or written reports on food spoilage, micro-organisms, and sewage treatment;
d) care and effort in participating in practical work, working safely, and completing tasks.

## 6. Safety Considerations

a) Pathogenic micro-organisms must not be used in experiments.
b) Students should wash their hands after handling materials containing micro-organisms.
c) Disposable petri dishes should be used where appropriate.
d) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

## 7. Possible Extensions

Some students might:

a) culture and isolate non-pathogenic micro-organisms, using appropriate aseptic techniques;
b) investigate the safety procedures that the school kitchen follows with regard to cleanliness;
c) examine the role of the custodial staff in minimizing the spread of micro-organisms;
d) determine the methods used to dispose of the school's garbage;
e) inspect the garbage of a local supermarket to discover the methods employed to reduce the spread of bacteria;
f) record the temperature changes in a compost pile during a twenty-four-hour period;
g) determine how wine or beer is manufactured.

## 8. Some Teaching Suggestions

a) Students can visit a local supermarket to identify the various products and their origins. Methods used by the supermarket to keep food from spoiling can be investigated. If possible, it would be interesting to investigate waste disposal by a supermarket.
b) Samples of canned goods can be collected. The class can investigate the function of the materials listed under "ingredients" on the cans.
c) Students can collect food samples containing microbes, which can be grown in a microbe garden.

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*See the subsection entitled "Student Activities" on page 5.

d) Dried yeast should be added to lukewarm water ten minutes before examination. Students can examine the yeast under the microscope to observe a budding yeast cell. They can do a count of the yeast population over a five-day period and graph the results. The growth of bread mould can also be investigated by means of a hand magnifier.

e) A trip to a cheese factory or sewage-treatment plant can illustrate some roles of micro-organisms. A piece of meat, fish, or newspaper can be buried and examined after a few weeks for any changes caused by micro-organisms. A compost pile can be examined, and its use discussed.

f) Fermentation experiments using yeast and glucose can be designed. Temperature changes or the volume of carbon dioxide produced can be graphed. The rate of fermentation of different food sources (e.g., glucose, starch, sugar) can be compared. The potential of anaerobic respiration of manure as an energy source can be examined.

g) Numerous recipes may be used for bread or yogurt making. The yogurt bacteria can be obtained from a cheese factory or from a container of commercial yogurt. Natural and commercially prepared bread can be examined.

h) Micro-organisms can be found in any vicinity. Swabbing with a damp cotton swab is an easy means of obtaining these organisms. Bread mould is an excellent specimen for microscopic examination. Photomicrographs can be used to observe the structures of micro-organisms. Micro-organisms can be classified according to their shape, reaction to stains, or method of movement.

i) Food spoilage can be examined by exposing prepared cultures to unfavourable environmental conditions. These cultures can be compared to a control culture. By this means the effects of such factors as temperature, radiation, composition of medium, pH, pressure, and smoking can be investigated.

j) The following are examples of new topics and units that can be developed from the topics in this unit:

| Topics in This Unit | Additional Topics or Units |
|---|---|
| Supermarket products | Food production and marketing |
| Rotting and spoilage | Termites |
| Micro-organisms | Microscopy<br>Protozoans |
| Preserving food | Product safety<br>Human health and disease |
| Micro-organisms and industry | Public health<br>Dairy products<br>Fungi |

Optional Unit 6

# Locally Designed Units (LDUs)

*Time: About 20 hours each*

The time remaining *after* the core unit and at least three of the optional units 1 to 5 have been taught is to be used for locally designed units. These units can be used to introduce a new area or topic of science not described in this guideline or to incorporate additional objectives that will expand a previous part or parts of the course. The following are examples of new areas or topics that might be considered:

- Adaptations of plants and animals
- Agriculture
- Astronomy
- Chemicals
- Cosmetics
- Electricity
- Food science
- Forestry
- Fungi
- Horticulture
- Mining
- Outdoor studies

Such units can provide an excellent opportunity for students to engage in independent individual or small-group study on a topic in science that is of particular interest to them and that is approved, monitored, and evaluated by the teacher. Care should be taken not to allow the work to overlap with subject matter in other science courses that students have taken or are likely to take. Independent study involving laboratory work should be started only after students have had ample experience in the laboratory and are well aware of accident prevention. If a series of short topics is considered, these topics may be fitted into the course schedule from time to time throughout the semester or year.

Locally designed units are to incorporate the following components: objectives, student activities, applications, societal implications, safety considerations. An outline of these units is to be included with the school's course outline and kept on file so that it is available to interested students and parents.

# Science, Grade 12, Basic Level
## (SNC4B)

**Core Unit**

The Wise Use of Energy

*(Up to 30 hours)*

**Optional Units**

Physics at Work
Sound
Heredity
The Changing Environment
Photography
Locally Designed Units (LDUs)

*(About 80 hours)*

Core Unit

# The Wise Use of Energy

*Time: Up to 30 hours*

To be effective, energy conservation should begin with an examination of the way energy is used each day. The details of energy consumption, including energy-consumption habits and the way in which energy costs are affected by these habits, are not often examined by students. An examination of an inventory of household energy use can help students gain an appreciation of the energy demands of larger units such as towns, cities, or a whole province.

In this unit students will be given the opportunity to examine the use of energy in their homes and to calculate the cost of the energy used. From this study they will be able to identify specific ways in which energy consumption can be reduced in their homes.

This unit may be divided into topics such as the following:

- Sources of energy
- Using electrical energy
- Measuring energy use
- Insulation
- Energy conservation

## 1. Objectives

At least one-half of the objectives from each of the following categories are to be selected.

***Attitudes.*** Students will be encouraged to develop:

a) a concern for evaluating the data and costs itemized on different types of energy bills (3d, 4d);
b) an appreciation of the need to conserve energy (4a, 4c, 4g);
c) an appreciation that our lifestyle is dependent on cheap and abundant energy (3e);
d) a commitment to practising energy conservation (3e, 3f, 4e);
e) an awareness that the practice of energy conservation can save money and natural resources (4d);
f) a curiosity about the role of science and technology in developing more efficient materials and methods to help reduce the amount of energy wasted (3i, 4g).

***Skills.*** Students will have the opportunity to develop skill in:

a) measuring temperature using a Celsius thermometer (2b, 2e-2g);
b) using experimental data on the rate of heating of different liquids to identify the factors that determine the heat content of a substance (2b);
c) reading and recording data from devices such as hydro meters, gas meters, and water meters (2c);
d) interpreting information on hydro and fuel bills (2c);
e) tabulating data gathered on the duration of use of electrical appliances (2d);
f) interpreting data in tabular form (2a, 2d);
g) calculating, from a structural drawing, the total insulating value of a wall constructed of different materials (2g);
h) using a chart of wet- and dry-bulb temperature readings to determine relative humidity (2e);
i) searching information from a wide variety of library sources, such as encyclopedias, magazines, and journals (2h).

***Knowledge.*** Students will be expected to:

a) state the meaning of or correctly use the following terms: energy, non-renewable energy source, power, heat, temperature, conservation, relative humidity, insulation, R value;
b) explain that the amount of heat in a substance depends on the temperature change of the substance, the mass of the substance, and the type of substance (2b);
c) explain that when energy is converted from one form to another, there is a loss of energy, which is largely heat (2f, 2g);
d) list three methods used to produce electricity in Ontario;
e) state the units used to measure electrical energy and heating-fuel consumption (2c);
f) list methods of reducing hydro-electric costs in the home, on the farm, or in industry (2d, 2h);
g) list methods of reducing heating costs in the home (2f, 2g, 8g);
h) list major causes of heat loss in the home and state one method of reducing each loss (2e-2g);
i) list several methods of insulating dwellings and compare their effectiveness (2g);
j) describe the effects of humidity on the home environment and its inhabitants (2e);
k) explain some possible effects on lifestyles of reducing energy consumption (2a, 2d);
l) list some non-renewable and renewable energy sources (2h).

## 2. Student Activities

Students are to:

a) make a list of one day's activities requiring energy, name the energy need in each activity (e.g., light, chemical, electrical), state the source of the energy (e.g., food, oil), summarize the data by means of a chart, and rank the energy sources from most used to least used;

b) compare the temperatures of equal masses of different liquids after they have been heated with the same heat source for a given period of time (6a, 8a, 8b);

*c) investigate the metering, billing, and costs of residential electricity or heating fuel (5b, 6b, 8c, 8d);

d) (i) carry out a survey of the use of electrical appliances during a typical evening or day and determine the costs of their use with the aid of a table of the typical power ratings of the appliances; (ii) rank the use of each appliance on a necessity-of-use scale, from very necessary to not necessary; (iii) suggest alternatives for those appliances that are ranked as not necessary (8b, 8h);

*e) carry out an experiment to determine the relative humidity and relate this to temperature settings, heat conservation, comfort, health, and environmental factors such as static electricity, and furniture and fabric wear (5c, 6a, 8e);

f) carry out an experiment to investigate passive methods of cooling a building, such as by convection, reflection, or evaporation (6a);

g) (i) examine the insulating properties of commonly used building materials, their use in various combinations in outer-wall construction, and the areas of heat loss in homes or (ii) perform an experiment to investigate how well various materials insulate hot water, graph the temperature changes of the water, and rank the insulating materials from the most to the least effective (6a, 8f);

h) prepare an oral or a written report describing a renewable energy source for use on the farm or in the home or some other building. Examples might include biomass methane production, solar passive heating, biomass methanol production, and tidal power (8h).

## 3. Applications

a) Some substances, such as water, are able to store large amounts of heat, which can later be released to heat buildings.

b) The ability to store, reflect, or radiate heat is an important property to consider in the choosing of building materials.

c) Effective energy conservation depends on the control of the waste heat produced in energy conversions.

d) The monitoring of energy bills is a means of assessing the effectiveness of the methods used to reduce energy wastage.

e) The power rating of an appliance can be an important factor in the decision to purchase a product.

f) Retrofitting many existing heating systems is possible to increase efficiency.

g) The relative humidity of a home plays an important role in the health of the occupants, in the degree of airborne pollutants, and in the operation of electronic air cleaners.

h) Excessive dryness weakens glued furniture joints, increases the wear on fibres, and increases the production of static electricity.

i) The efficiency-cost ratio of insulating materials should be a factor in planning modifications to existing facilities.

j) Passive cooling and heating methods may be used to reduce home and industrial energy costs.

k) The use of renewable energy sources can reduce farm, home, and industrial energy costs.

## 4. Societal Implications

a) Energy conservation at all levels of society is required if the present standard of living is to be maintained.

b) A need exists for the development of less expensive techniques to store and exchange heat that might be wasted or that might cause environmental damage.

c) The inefficient operation of heating systems is not only costly but also produces harmful pollutants.

d) There is a need to plan the siting of houses to maximize energy conservation and use the environment to moderate building temperatures.

e) The costs of home ownership or building maintenance can be reduced through energy conservation.

f) The burning of the products of the degradation of waste biomass has been used successfully to heat barns and sewage-treatment plants.

g) The total efforts of individuals, private industries, and governments need to be focused in the same direction to reduce the wasting of energy and non-renewable resources.

## 5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on such activities as students':

a) use of tables in retrieving and recording data;

b) accurate reading and interpreting of utility meters;

c) experimental determination of relative humidity;

d) performance of and reporting on experiments;

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*See the subsection entitled "Student Activities" on page 5.

e) care and effort in gathering information, following instructions, and completing tasks;
f) oral or written reports.

## 6. Safety Considerations

a) Thermometers should be secured in position when immersed in liquids that are being heated. The bulbs should not be in direct contact with containers.
b) When examining utility meters, students should be warned about the possible dangers and damage that can result from manipulating them, and they should be aware that such manipulation is illegal.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

## 7. Possible Extensions

Some students might:

a) carry out an experiment to test the thermal insulating and conducting properties of different materials;
b) compare the utility bills for given periods in a year with the average temperatures over the same periods and identify any trends in power demand;
c) make a study of the power ratings of similar appliances, such as microwave, convection, and standard ovens, and include a study of the time required in each case to perform the same task;
d) investigate the operation of a solar collector and a heat pump and the use of swimming pools and water tanks to store heat;
e) investigate the relationships among humidity, wall construction, and insulation and the role of rugs and drapes in reducing heat loss;
f) investigate the variables used in determining R value and design an experiment to test this property;
g) predict the changes in our lifestyle that might occur if energy were rationed and propose related priorities for consumption in a community (the "brown-out" conditions experienced in certain cities might be used as a model);
h) visit or investigate self-sufficient ecology houses or houses or buildings using solar power or self-contained heating systems to study the techniques used;
i) study the use of biomass as a fuel source for farm buildings, sewage-treatment plants, or other applications.

## 8. Some Teaching Suggestions

a) The heating of equal masses of different liquids, such as water and vegetable oil, with the same heat source, can be used to demonstrate the difference between heat and temperature. A hot plate used with a double boiler is an excellent heat source.
b) Undue stress should not be introduced through unnecessary emphasis on mathematical work. Students can use calculators or conversion tables or can work in groups to do mathematical calculations.
c) Utility bills should be standardized for class use. A utility-company representative can visit the class to explain the operation of meters and reading and billing procedures.
d) Utility companies, government, and private agencies provide data and other resources concerning power demands, power ratings, and annual temperature variations.
e) A wet- and dry-bulb thermometer can be constructed by securing a lamp wick, its end submerged in water, over the thermometer bulb.
f) Plans for wall and ceiling construction can be found in many architectural drafting texts. Companies manufacturing insulating materials provide a wide range of resources.
g) The design of houses should suit local conditions more than they should serve aesthetic needs. The designs of houses in different societies meet a variety of needs and might be compared.
h) Students should be encouraged to publish or display their findings in the form of a newsletter or on bulletin boards in an effort to make other students aware of the role they can play in energy conservation and the savings that can be made.
i) The following are examples of new topics and units that can be developed from the topics in this unit:

| Topics in This Unit | Additional Topics or Units |
|---|---|
| Sources of energy | Transportation of energy |
| Using electrical energy | Electrical appliances<br>Forms of electrical energy |
| Measuring energy use | Human energy<br>Electrical energy<br>Heat energy |
| Insulation | Clothing in different climates<br>Animal protection<br>Protection of plants |
| Energy conservation | Landscaping<br>Alternative energy sources<br>Recycling<br>Use of water |

Optional Unit 1

# Physics at Work

*Time: About 20 hours*

Students will be entering a world of work in which technology plays a major role. Many technologies are based on simple laws of physics. An understanding of such laws can be an asset in obtaining future employment. In this unit students will have an opportunity to study some of the physical laws governing buoyancy, pressure, and electricity.

This unit may be divided into topics such as the following:

- Floating and sinking
- Pumps and siphons
- Heat transfer
- Current electricity
- Electromagnetism
- Safety in the workplace

## 1. Objectives

At least one-half of the objectives from each of the following categories are to be selected.

***Attitudes.*** Students will be encouraged to develop:

a) an appreciation for the design and use of common tools, instruments, and machines that are employed in the trades, in the home, and in industry (3a, 4c);
b) a curiosity in determining how a device operates (4c);
c) an appreciation for the relationship between a physical principle and its application;
d) a commitment to following fundamental safety rules and regulations governing the operation of equipment (4a).

***Skills.*** Students will have the opportunity to develop skill in:

a) following instructions in a logical sequence;
b) assembling equipment by following written instructions and schematic diagrams (2b, 2e);
c) recording and organizing data from experiments and activities;
d) drawing simplified schematic diagrams to describe or record observations, explain basic principles, or illustrate new designs (2a-2g);
e) searching material on safety regulations from sources such as the Industrial Accident Prevention Association, Workers' Compensation Board, and Ministry of Labour manuals and reference materials (2h).

***Knowledge.*** Students will be expected to:

a) define or correctly use the following terms: energy, kinetic energy, potential energy, force, work, power;
b) define or correctly use the terms *flotation* and *buoyancy*;
c) explain and give practical examples of how water or any fluid seeks its own level (2a);
d) describe the relationship among force, area, volume, and pressure in water or any fluid (2a);
e) describe the relationship between low- and high-pressure areas that allows a siphon, pump, or sprayer to work (2b);
f) define or use correctly the following terms: convection, conduction, radiation (2e);
g) define or correctly use the following terms: circuit, series circuit, parallel circuit, magnet, magnetic field, electromagnet;
h) describe how a simple electromagnet can be constructed (2g);
i) describe how the strength of an electromagnet can be increased (2g);
j) describe how electrical energy can be converted into kinetic energy (2g);
k) list five safety practices related to mechanical, fluid, or electrical devices that should be followed in work on the farm, in the home, in the school, or in industry (2h).

## 2. Student Activities

Students are to:

*a) demonstrate (i) that water seeks its own level, *or* (ii) that the pressure of a liquid increases with depth, *or* (iii) the action of a spirit level, *or* (iv) the action of a Cartesian diver, *or* (v) the buoyancy of materials in water (5b, 8a-8c);
b) perform an experiment to (i) demonstrate the construction and application of a siphon, *or* (ii) investigate the action of simple suction-and-force water pumps, *or* (iii) demonstrate a simple water sprayer constructed from a flask, capillary tubing, straws or glass tubing, and a stopper (5b, 8d);

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*See the subsection entitled "Student Activities" on page 5.

*c) perform experiments to investigate (i) the formation of convection currents in air and water, *or* (ii) heat conduction in metals and other materials, *or* (iii) heat transfer by radiation (5c, 6b, 6c);
d) perform an experiment to demonstrate the expansion of metals and other materials, including water and air, when heated (6b, 6c);
e) construct a simple circuit board to demonstrate the effects of a switch, a fuse, lamps connected in series, and lamps connected in parallel (5d, 6d, 8e);
f) perform an experiment to demonstrate the magnetic field around a bar magnet, a horseshoe magnet, or an electromagnet (5d, 6d);
g) (i) construct a simple electromagnet and compare the fields produced by the electromagnet when cores of air, glass, iron, steel, and copper are used, *or* (ii) construct a circuit with an electromagnetic switch to control a flashing light or ringing bell, *or* (iii) perform an experiment to demonstrate the function of magnets in a simple DC motor (5d, 6d);
h) prepare an oral or a written report on safety practices, rules, or regulations related to the use of mechanical, fluid, or electrical devices on the farm, in the home, in the school, or in industry (5e).

## 3. Applications

a) Improvement in tool and machine design is possible when the scientific principles are understood and applied.
b) Electronic circuitry has its origins in simple circuits.

## 4. Societal Implications

a) A knowledge of safety standards can lead to safer working conditions for employees in the workplace.
b) Many occupations are accessible to students interested in the application of physics.

## 5. Evaluation

At least 50 per cent of the term mark for this unit is to be based on such activities as students':

a) care and effort in participating in practical work;
b) demonstration of a principle that applies to fluids;
c) manipulation and use of the laboratory equipment used to investigate heat transfer;
d) observations of, and accurate recording of data related to, electrical experiments;
e) written or oral reports on safety practices, rules, or regulations.

## 6. Safety Considerations

a) Instructions should be given to students on the proper care and use of the laboratory equipment used in this unit.
b) Students should be cautioned about, and instructed in, the proper use of an open flame. Loose clothing should be secured, and long hair tied back. Proper safety equipment should be available.
c) Flammable materials should not be exposed to an open flame. A beaker of hot water can be used as a heat source in testing the conductivity of materials such as nylon or Styrofoam.
d) All instruments or machines using alternating current should have appropriate safety approval. When direct current is used, power should be limited to 12 V. Students should be reminded of the safety rules regarding electricity.
e) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

## 7. Possible Extensions

Some students might:

a) visit a car dealer to examine safety features on cars;
b) investigate the properties of light and colour;
c) explain the operation of a rotating lawn sprinkler;
d) examine the methods of production and transmission of electricity in Ontario;
e) read about and report on the effects of streamlining and air dams on the performance of the modern automobile;
f) examine heat pumps, solar pool blankets, or solar heaters.

## 8. Some Teaching Suggestions

a) Some of the topics in this unit may have been studied by students in other courses; it is therefore important to determine how much basic theory students have been exposed to in the areas to be covered. The teachers of science and technological studies should plan topics and projects co-operatively in order to present this unit in an interesting, relevant, and challenging manner.
b) There are several parts to many of the student activities. If the teacher desires, the various parts may be assigned to different groups of students, who can perform the activities and then demonstrate them to the class, lead the class in a discussion of the principles involved, and introduce related applications and societal implications.

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*See the subsection entitled "Student Activities" on page 5.

c) An eyedropper can be used as the sinker for the Cartesian diver. The amount of water in the eyedropper should be adjusted so that the rubber part floats even with the surface of the water. When the pressure in the container is increased, the eyedropper should sink; when it is reduced, the eyedropper should rise. Explain to students that this theory also governs ships, submarines, and balloons.

d) Bernoulli's principle states that as the velocity of a fluid flow increases, the pressure it exerts decreases. This can be demonstrated by placing a straw in a glass of water and blowing across the end of the straw with a second straw held at right angles to the first. A spray of water will be produced. Students should be able to give simple explanations of the action of such items as siphons and water pumps.

e) A circuit board consisting of a number of lamps can be constructed. Students can arrange the lamps in a number of designs for practical and display purposes.

f) The following are examples of new topics and units that can be developed from the topics in this unit:

| Topics in This Unit | Additional Topics or Units |
|---|---|
| Floating and sinking | Ships and boats<br>Archimedes' principle |
| Pumps and siphons | Fluids in automobiles |
| Heat transfer | Home heating<br>Applications of radiation |
| Current electricity | Household circuits<br>Electrical lighting<br>Electrical appliances |
| Electromagnetism | Motors<br>Generators<br>Transformers |
| Safety in the workplace | Government regulations |

### Optional Unit 2

# Sound

*Time: About 20 hours*

This unit will provide students with opportunities to investigate the characteristics of sound. It may be divided into topics such as the following:

- Vibrations and the production of sounds
- The transmission and speed of sound
- Waves
- Properties of sound
- Noise and music
- Musical instruments

## 1. Objectives

At least one-half of the objectives from each of the following categories are to be selected.

***Attitudes.*** Students will be encouraged to develop:

a) a respect for the use of sound equipment or musical instruments (3d, 4b);

b) a concern about noise pollution and the dangers of long-term exposure to high-intensity sound (3d, 4b);

c) a curiosity about the applications of sound in modern life (3a-3c, 4c, 4d).

***Skills.*** Students will have the opportunity to develop skill in:

a) manipulating laboratory equipment such as a tuning fork, pendulum, spring, stopwatch, or sonometer (2a, 2b, 2e);

b) graphing, for example, the amplitude versus frequency for a vibrating object (2b);

c) determining the period of a transverse wave (2b);

d) predicting how sounds, including music, are produced and transmitted (2a, 2c, 2h);

e) recording some characteristics of sound waves (2c, 2f, 2g);
f) following procedures to determine the speed of sound (2e);
g) interpreting the data obtained from determining the properties of sound, for example, frequency and amplitude determine pitch and intensity (2a, 2c, 2e);
h) seeking information from a variety of library sources, such as encyclopedias, magazines, journals, and software programs (2i).

***Knowledge.*** Students will be expected to:

a) define or correctly use the following terms: transverse vibration, longitudinal vibration, period, frequency, amplitude, pendulum, medium, music, noise, intensity, pitch, quality (2a-2d, 2f-2h);
b) identify sources of sounds and the characteristic that is common to all such sources (2a, 2h);
c) describe an experiment that shows that sound requires a medium for transmission (2c);
d) demonstrate how an echo is produced (2e);
e) describe how to determine the speed of sound (2e);
f) indicate differences between noise and music and describe how these differences can be demonstrated (2f);
g) list four or five sounds, some of which are music and some noise, and describe their effects on human health (2f);
h) list three methods to reduce the adverse health effects of high-intensity sound;
i) describe the factors affecting intensity, pitch, and quality of sound (2g);
j) classify musical instruments and describe how each group of instruments produces sounds.

## 2. Student Activities

Students are to:

a) perform experiments to determine how sounds are produced (8a);
*b) (i) determine the effect of length, amplitude, and mass on the frequency of a pendulum *or* (ii) determine the effect of amplitude and mass on the frequency of a spring (5a, 8b, 8d);
c) demonstrate that a material medium is required for the transmission of sound (8c);
d) investigate some properties of transverse and longitudinal waves (8d);
e) demonstrate how the speed of sound is determined and investigate the laws of reflection of sound (echoes) (8e, 8f);
*f) investigate the difference between music and noise and, if feasible, show the different wave patterns by means of an oscilloscope (5b, 6, 8g);
g) (i) determine the factor that affects the intensity (loudness) of a sound, or (ii) determine the factor that affects the pitch of a sound, or (iii) determine the factors that influence the quality of a sound (6a, 8g);
h) examine string, wind, and percussion instruments to determine how they produce sounds (6a, 8h);
i) prepare an oral or a written report describing an application of sound technology in the home, industry, or research, for example, computer-synthesized music, home stereo systems, sonar oil and gas exploration, ultrasound (5d).

## 3. Applications

a) An interest in audio systems and the mixing of sounds may lead to a career or part-time job in this field.
b) Acoustics and sound insulation are important concepts for the building-construction industry.
c) Ultrasonic waves are used in fathometers (echo sounders), in medical and surgical diagnosis, and by industry (e.g., for checking brake linings in cars).
d) The intensity of sound can be measured in decibels. Decibel ratings help determine whether sounds are approaching the threshold of pain.

## 4. Societal Implications

a) Many people enjoy listening to music or participating in its production.
b) The high-intensity sounds produced by some stereo systems can cause permanent ear damage.
c) An appreciation of the difficulties of hearing-impaired people is important for all people.
d) Ultrasonic waves are used in many industrial and medical applications.

## 5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on such activities as students':

a) performing of experiments to determine the factors that affect the frequency or period of a pendulum or spring;
b) listing of sources of noise and music and their effects on human health;
c) successful completion of the tasks assigned;
d) submission of reports or projects on modern uses of sound.

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*See the subsection entitled "Student Activities" on page 5.

## 6. Safety Considerations

a) Students must handle sensitive equipment such as oscilloscopes and musical instruments with care.
b) Electrical equipment should have appropriate safety approvals.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

## 7. Possible Extensions

Some students might:

a) determine the similarities and differences between light and sound as forms of energy;
b) design an experiment to determine the speed of sound in different solids and liquids;
c) find out how sound is transmitted from the eardrum to the auditory nerve;
d) investigate how the human voice is produced;
e) make musical instruments in the classroom;
f) visit a hospital to view an ultrasound unit;
g) obtain a sound meter and list the intensity levels of sound from several different sources;
h) investigate the human ear and various animal auditory organs and determine how they aid hearing in the organism's environment;
i) find out about the difficulties experienced by people with serious hearing impairments.

## 8. Some Teaching Suggestions

a) Students can hold a discussion on the importance of sound in their lives. They can demonstrate the relationship of vibrations to sound by placing dried peas on a drum or paper riders on the strings of a guitar, gently touching the diaphragm of a woofer in a loudspeaker, or touching the larynx in their neck.
b) The class can be divided into groups for the pendulum and spring activities. One group can demonstrate the activity for the rest of the class. Simple data collection should be stressed.
c) A bell jar, bell, vacuum pump, and power source are necessary to demonstrate the need for a material medium for the transmission of sound. Students can discuss whether sounds can be heard in space, in water, and through a wall.
d) Slinky springs are useful for demonstrating waves.
e) Using two hollow tubes and a smooth shield as a reflecting surface, students can design an activity to show that sound can be reflected. Different reflecting surfaces, such as glass, cloth, acoustic tile, and aluminum foil, can be used, and students can predict which materials will be good and which poor reflectors of sound. The importance of reflectors and absorbers of sound, such as acoustic tiles and soundproofing, can be discussed.
f) Students can use a 100 m playing field, stopwatch, measuring tape, and starter's pistol to determine the speed of sound. They can also accomplish this by measuring the time it takes for an echo to return 50 m from a building. Students can determine, by counting seconds between a lightning flash and thunder, approximately how far away the flash takes place.
g) An oscilloscope is useful to illustrate differences in sound waves. Saw-toothed wheels with unevenly and evenly spaced teeth can be used to demonstrate differences in sounds.
h) The music department in the school may be able to provide some instruments for examination. Students can observe the differences between percussion (e.g., drums, cymbals), wind (e.g., saxophones, trumpets), and stringed instruments (e.g., violins, guitars). The piano can be discussed as an example of an instrument that is both a stringed and a percussion instrument.
i) The following are examples of new topics and units that can be developed from the topics in this unit:

| Topics in This Unit | Additional Topics or Units |
|---|---|
| Vibrations and the production of sounds | The human body<br>Resonance |
| The transmission and speed of sound | Acoustics<br>Echo sounders<br>The sound barrier<br>Supersonics<br>The telephone<br>Radio |
| Waves | Water waves<br>Light waves |
| Properties of sound | Frequency ranges<br>The decibel scale |
| Noise and music | Deafness<br>Insulation<br>Harmonics |
| Musical instruments | Orchestras and bands<br>Computer synthesis of music |

Optional Unit 3

# Heredity

*Time: About 20 hours*

Who we are depends on the genetic characteristics that we inherit from our parents as well as on the environment in which we live. The study of genetics can give us an insight into how we inherit certain traits. In this unit students will learn about inherited traits and pedigrees, the laws of genetics, and some human genetic diseases.

This unit may be divided into topics such as the following:

- Mendelian genetics
- Human reproduction
- Human genetics
- The genetic code
- Genetics and the environment

## 1. Objectives

At least one-half of the objectives from each of the following categories are to be selected.

***Attitudes.*** Students will be encouraged to develop:

a) an appreciation of the diversity of human characteristics (3a);
b) a concern for offspring that may have a genetic disorder (3b, 3d, 4b, 4c);
c) a commitment to respect others (4c);
d) a curiosity about the role of the environment and inherited traits in influencing a person's appearance;
e) open-mindedness towards the fact that changes in genes may be beneficial or harmful to an individual or a species (3b, 3d, 4a, 4b);
f) a commitment to improving the quality of their lives by increasing their awareness of their heredity and environment (3a, 3b, 4a, 4b).

***Skills.*** Students will have the opportunity to develop skill in:

a) making and interpreting pedigrees for a single trait (2a, 2b);
b) using a Punnett square to determine the genotype and phenotype of the offspring for a single trait (2c, 2f);
c) deciding from suitable evidence whether or not a characteristic is inherited (2b, 2c);
d) observing both sperm and egg cells under the microscope (2d).

***Knowledge.*** Students will be expected to:

a) define or illustrate the following terms: trait, dominant, recessive, chromosome, gene, gamete, zygote (2a, 2c);
b) given suitable data, state the number of chromosomes in the normal body cells and in the gametes of an individual (2e);
c) demonstrate examples of inheritance by drawing Punnett squares or pedigrees, using specific human characteristics (2b, 2c);
d) state at least two inherited human characteristics and the dominant and recessive forms of each (2a-2c);
e) describe the structure and function of the parts of the male and female reproductive systems (2d);
f) recall that the genetic code is the basis of inheritance (2e);
g) explain sex determination in humans (2e);
h) recall three genetic and chromosomal disorders, such as Down's syndrome, sickle-cell anemia, hemophilia, Tay-Sach's disease, and muscular dystrophy (2a, 2e, 2i);
i) differentiate between fraternal and identical twins (2i);
j) list environmental agents that can cause mutations (2i).

## 2. Student Activities

Students are to:

*a) observe and tabulate at least two single traits that are genetically determined, such as tongue rolling, ear-lobe attachment, thumb shape, and thumb position on hand clasping (5a, 8a);
b) investigate and prepare a pedigree for the continuation of a trait within a family (5c, 8b);
c) draw Punnett squares to explain patterns of inheritance for at least two human characteristics (5c, 8c);
*d) examine prepared slides showing sperm and egg cells (5b, 8f);
e) using photographs of human karyotypes, determine the chromosome number and sex of at least three individuals (8d);
f) examine the laws of probability by repeatedly tossing coins and relate this to genetic crosses (8c);
g) investigate human blood-group inheritance (8c);

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*See the subsection entitled "Student Activities" on page 5.

h) examine the reproductive system through a prepared dissection or a model of a mammal such as a rat or fetal pig (6a, 6b, 8f);
i) visit the school's library resource centre or a local library and write a report on one of the following: a genetic or chromosomal disorder, environmental agents that can cause mutations (e.g., chemicals, radiation), or identical versus fraternal twins (8g, 8h).

## 3. Applications

a) Some characteristics of human offspring can be predicted from pedigrees and modern technological advances.
b) Amniocentesis and ultrasound techniques can be used to identify certain diseases and abnormalities before birth. Parents can obtain appropriate genetic counselling as a result of this technological advance.
c) Genetic manipulation has provided a new means of manufacturing some important chemicals.
d) Genetic control of insect and plant diseases may reduce the need for pesticides and fertilizers.

## 4. Societal Implications

a) Techniques such as amniocentesis are used to identify chromosome disorders in the fetus prior to birth.
b) Drugs and alcohol, airborne mutagenic agents, and sexually transmitted diseases may affect an unborn child.
c) The responsibility for individuals with genetic disorders must be shared by all people.

## 5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on such activities as students':

a) participation in group work to complete a tabulation of human characteristics;
b) use of microscopes to observe egg and sperm cells;
c) completion of assigned tasks, such as those involving pedigrees and Punnett squares;
d) ability to recognize the parts of the human reproductive systems from photographs or diagrams.

## 6. Safety Considerations

a) Gloves and appropriate eyewear should be worn during dissections.
b) Students are to wash their hands immediately after handling specimens.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

## 7. Possible Extensions

Some students might:

a) investigate the origin and use of the symbols for male and female;
b) construct simple models for DNA, RNA, and the genetic code;
c) visit an ultrasound unit in a local hospital.

## 8. Some Teaching Suggestions

a) Hair colour, eye colour, and skin colour are not singly inherited traits. Students can be most easily grouped according to their ear-lobe attachment, ability to roll the tongue, thumb shape, or thumb position on grasping of hands. It must be remembered that the dominant trait is not necessarily the most common form of the gene.
b) Survey sheets can be set up to investigate family traits and to prepare pedigrees and family trees. Although this activity makes a good project and can be extended into a written or an oral activity, it should not be mandatory. Consideration must be given to students who were either adopted or who come from single-parent homes. As an alternative, the pedigree of a famous family could be studied (e.g., the royal families of Europe and hemophilia).
c) A coin toss may be used to show the probability of 3:1 ratios. Sex-linked inheritance (e.g., colour blindness, baldness, hemophilia) and incomplete dominance (e.g., blood grouping) may be mentioned. Students may already know their blood group.
d) Karyotypes may be available from a local hospital as well as from commercial publishers. Sex determination by Punnett square and karyotype could be discussed.
e) The genetic code and the preservation of chromosome number should be mentioned but not dealt with in detail. They should be used as a means of explaining to students how chromosomes can pass on inherited traits from one generation to another.

f) Microscope and dissection techniques should be reviewed carefully before students begin these activities. Dissection as an activity, if used, should be kept to a minimum.
g) Students are very concerned about genetic and chromosomal disorders. Down's syndrome and its relation to the age of the mother should be discussed. Diseases that are grouped by race, such as Tay-Sach's and sickle-cell anemia, should be mentioned. The right by law to do testing on new-born babies (e.g., for phenylketonuria – PKU) is an important issue.
h) The effects of drugs and alcohol on an unborn child should be discussed. Airborne mutagenic agents may be an interesting topic through which to introduce the subject of the effects of the environment on humans.
i) The following are examples of new topics and units that can be developed from the topics in this unit:

| Topics in This Unit | Additional Topics or Units |
|---|---|
| Mendelian genetics | Plant genetics<br>Animal genetics |
| Human reproduction | Meiosis and mitosis<br>Embryology |
| Human genetics | Human biology |
| The genetic code | Genetic engineering |
| Genetics and the environment | Environmental hazards |

Optional Unit 4

# The Changing Environment

*Time: About 20 hours*

The environment contains living and non-living things that exist together in a delicate balance. An understanding of the interactions that take place in the environment is important in terms of long-range planning, since people make decisions that affect the environment as they try to improve the quality of life (e.g., through improved crop yields, vaccination programs against disease, building-density codes). In this unit students will learn how to locate information and will attempt to make rational decisions regarding changes in the environment.

This unit may be divided into topics such as the following:

- Energy flows
- Food chains and food webs
- Population dynamics
- Environmental concerns

## 1. Objectives

At least one-half of the objectives from each of the following categories are to be selected.

***Attitudes.*** Students will be encouraged to develop:

a) a concern for the quality of the environment;
b) an appreciation of science's contributions to and limitations in solving environmental problems (4a, 8e);
c) a questioning attitude towards presently accepted environmental practices (3a-3d, 4c);
d) critical-mindedness towards the advances made by science and technology to overcome environmental hazards (3a-3d, 8e).

***Skills.*** Students will have the opportunity to develop skill in:

a) recording findings in an orderly manner;
b) making logical interpolations or extrapolations of experimental data (2a-2f);
c) following experimental procedures to investigate an environmental problem (2a-2c);
d) interpreting animal-population graphs;
e) interpreting statistical and factual material from government and media sources (2e).

***Knowledge.*** Students will be expected to:

a) describe how carbon or nitrogen is cycled throughout the environment (2b);
b) use correctly the term *food chain* and describe one example of a food chain that includes the sun and at least two organisms (2a);
c) use correctly the term *food web* and describe one example of a food web that includes the sun and at least four organisms (2a);
d) use correctly the term *energy pyramid* and describe one example that includes at least three different organisms;
e) describe the background to a particular environmental problem (2e);
f) explain possible solutions to the selected environmental problem (2e);
g) describe changes in the wolf and deer or lynx and hare populations after examining appropriate population graphs.

## 2. Student Activities

Students are to:

*a) investigate algae and daphnia in a closed ecosystem over a period of four weeks, describing the food chain present and recording the results of adding a small amount of plant fertilizer to the system (5b, 6);
b) (i) perform an experiment to examine the effects of dilute sulphuric acid, dilute ammonia solution, dilute sodium hydroxide, detergent, and organic matter (humus) on a closed pond ecosystem *or* (ii) perform experiments to illustrate the greenhouse effect, using such items as large jars, a carbon dioxide generator, charcoal dust, and thermometers (5a, 6);
c) perform experiments to determine the pH of, and the amount of dissolved oxygen, carbon dioxide, ammonia, and nitrates in, a local pond, stream, or lake (5a, 6);
d) observe examples of radioactivity by means of a cloud-chamber demonstration;
*e) conduct a library search on a particular environmental problem and prepare an oral or a written report for the class (5c, 8b).

## 3. Applications

a) The possible destruction of the ozone layer of the atmosphere by pollutants is a concern.
b) The safe disposal of industrial and nuclear waste materials is a current environmental problem.
c) Modern pollution-control devices have reduced the emissions of smokestacks and automobiles.
d) Studies in population dynamics have led to the better management of flora and fauna in parks and nature reserves.

## 4. Societal Implications

a) All components of society must co-operate in reducing the risks caused by chemical emissions in the environment.
b) Continued research into improved agricultural methods may lead to increased food production and may reduce the number of people affected by food shortages.
c) Chemicals such as myrex, dioxin, and heavy metals are transferred through food chains and may eventually be consumed by humans.

## 5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit is to be based on such activities as students':

a) participation in the preparation and presentation of the results of laboratory investigations;
b) production of notes and a report on data related to food chains and food webs;
c) oral or written communication, particularly on an environmental problem, with the teacher and other students.

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*See the subsection entitled "Student Activities" on page 5.

## 6. Safety Considerations

a) Chemicals should be handled with care.
b) Weak acids and bases should be used.
c) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

## 7. Possible Extensions

Some students might:

a) invite local, provincial, or federal government personnel to the classroom to discuss environmental concerns;
b) visit industrial sites to investigate the management of waste;
c) investigate waste-management disposal methods in the community;
d) investigate how air pollution affects health.

## 8. Some Teaching Suggestions

a) This unit may be organized around a case-study approach to a particular environmental issue or concern. Time should be spent organizing students into groups and assigning to each group specific tasks that have achievable objectives.
b) Topics of environmental concern can be discussed to ascertain the main interests of students.
c) Many commercial simulation games dealing with topics suggested in this unit are available for use in the classroom.
d) This unit may be planned as an interdisciplinary unit. The role of other subject areas, such as English, family studies, and the social sciences, can be introduced in the discussions.
e) The following are examples of new topics and units that can be developed from the topics in this unit:

| Topics in This Unit | Additional Topics or Units |
|---|---|
| Energy flows | The greenhouse effect |
| Food chains and food webs | Limnology |
| Population dynamics | Food production |
| Environmental concerns | Hazardous-waste management<br>Acid rain |

Optional Unit 5

# Photography

*Time: About 20 hours*

Photography is a most rewarding hobby and can provide avenues to employment. The camera can be used in a variety of ways and for many purposes; for example, it can be used recreationally to capture memories and produce movies; commercially for advertising and media productions; and vocationally in the arts, detective work, scientific investigations, and aerial photography. This unit will involve students in activities involving the structure and use of the camera, in the development of photographic film, in a consideration of the eye as the body's camera, and in relating photography to the world of work and leisure pursuits.

This unit may be divided into topics such as the following:

- Light-sensitive papers
- The pinhole camera
- The simple camera
- Developing film
- The eye as a camera

## 1. Objectives

At least one-half of the objectives from each of the following categories are to be selected:

***Attitudes.*** Students will be encouraged to develop:

a) an appreciation that potentially poisonous and irritating chemicals can be handled safely when precautions are taken (3a-3d);
b) a co-operative attitude in working as a member of a group;
c) a concern for the need to conserve expensive materials that can be reused (4c);

d) a curiosity about the diverse roles played by photography in today's world (4d);
e) an appreciation of the eye as an important sensory organ of the body.

***Skills.*** Students will have the opportunity to develop skill in:

a) exposing and controlling the time of exposure of light-sensitive materials (2a-2c, 2e);
b) the techniques used in developing prints, handling exposed papers, and timing the stages of development to control contrast in photographic prints (2e);
c) accurately drawing ray diagrams to show how an image is formed by a lens (2d);
d) controlling an exposure with a pinhole camera to produce a satisfactory negative or print (2e);
e) using a camera to take a picture (2f);
f) making negative contact prints from opaque and translucent objects and from black-and-white negatives (2d).

***Knowledge.*** Students will be expected to:

a) explain that exposure to light causes silver compounds to undergo a chemical change, producing small and variegated grains of silver metal that produce photographic images (2a, 2b);
b) explain that black-and-white film and photographic paper contain a layer of light-sensitive silver compounds (2b);
c) list the steps in producing a print, including exposure to light, developing, stopping, fixing, and washing (2e);
d) explain that a developer speeds up the conversion of exposed silver compounds to silver (2b, 2c);
e) explain that the "stop bath" makes the developer stop producing silver grains (2b, 2c);
f) explain that the "fixer" removes unexposed silver compounds by dissolving them in water (2b, 2c);
g) state that light travels in straight lines (2d);
h) explain that a light beam is composed of many individual rays that can combine to form an image (2d);
i) use a diagram to explain why the pinhole-camera image is inverted (2d);
j) identify the parts of a simple camera by means of a diagram and state the function of each, including the shutter, shutter release, viewfinder, lens, lens opening, and film-advance mechanism (2f);
k) identify the main parts of the human eye, comparing the function of each part with the corresponding part of a camera (2g).

## 2. Student Activities

Students are to:

a) prepare blueprint paper and make a shadowgram of several objects (6a, 6c, 6d, 8a, 8b);
b) prepare photosensitive papers, using different silver compounds, and compare their reaction to sunlight, both with and without developing (6b-6d, 8a-8f);
*c) (i) make a photograph of objects of different optical densities *or* (ii) make a contact print from a photograph or a negative (5a, 5b, 6b-6d, 8h, 8i);
*d) (i) construct a pinhole camera and use it to study the formation of an image on the screen *or* (ii) carry out an experiment showing how light from an object passes through a double convex lens to produce an inverted image and illustrate it with a ray diagram (5c, 5d, 8g, 8i);
e) produce and develop a photograph taken with a pinhole or commercial camera (5e, 6b-6d, 8g, 8h);
f) (i) identify the parts of a simple camera and describe the function of each *or* (ii) use a camera to take a series of pictures to show the effects of correct and incorrect settings (8i);
g) dissect a cow's eye and identify the lens, retina, cornea, and pupil (6e).

## 3. Applications

a) The blueprinting process is widely used in the reproduction of architectural and engineering drawings.
b) Photographic technology is widely used in the printing industry.
c) Photocopiers employ various scientific principles.
d) Video cameras are modern applications of photographic technology.
e) Modern cameras can be used to photograph objects in many different environments and circumstances (e.g., microphotography, astronomy).

## 4. Societal Implications

a) Photochemical reactions contribute to the smog that has proved dangerous in cities such as Los Angeles.
b) Photosensitive silver compounds have led to the development of a wide variety of useful products, such as photocopiers, "photogrey" eye glasses, and photocells.
c) The world shortage of silver has led the photographic industry to recover 60 to 80 per cent of the original silver removed during film processing.

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*See the subsection entitled "Student Activities" on page 5.

d) The development of photography has added an invaluable dimension to the recording of history and has increased people's awareness of the world.
e) Photography is a hobby that is enjoyed by many and provides a means of employment for some.

## 5. Evaluation of Student Achievement

At least 50 per cent of the term mark for this unit should be based on such activities as students':

a) producing photographs;
b) producing contact prints;
c) forming an image by means of a pinhole camera or converging lens;
d) drawing accurate ray diagrams;
e) producing positive prints from negatives.

## 6. Safety Considerations

a) Potassium ferricyanide is poisonous, and appropriate precautions should be taken in its use.
b) Many of the compounds used in photography, such as silver nitrate, can stain the skin and clothing. Silver stains should be rinsed immediately with sodium thiosulphate and then washed with soap and water.
c) Students should be cautioned that some chemicals used in photographic work cause irritation of the skin, eyes, and mouth and that they should report any such reaction to the teacher.
d) Students should wear rubber or plastic gloves when handling photographic and blueprinting chemicals.
e) Students should wear rubber or plastic gloves when handling preserved specimens.
f) For further information on safety, teachers should refer to Part 1, section 9, of this guideline.

## 7. Possible Extensions

Some students might:

a) prepare blueprints from solid-line drawings;
b) carry out an experiment to illustrate the role of the fixer on exposed and unexposed silver halide;
c) prepare test sheets to determine the best exposure times for blueprints, photograms, and contact prints;
d) make photograms of natural objects, such as insect wings, flower parts, and leaf skeletons, to form a collage;
e) construct a pinhole camera using a 126 film cartridge;
f) carry out an experiment with a pinhole camera to determine the effects of exposure time, pinhole size, and multiple pinholes on image quality;
g) bring in cameras to demonstrate their operation and photographs to show a variety of photographic techniques;
h) invite a photographer to visit the classroom to show examples of his/her work and equipment or to demonstrate the complete process of developing;
i) investigate the methods used to correct near-sightedness and far-sightedness.

## 8. Some Teaching Suggestions

a) Samples of student work should be used to stimulate interest and confidence at the beginning of each activity.
b) Blueprint paper may be made by coating drawing paper with a solution of five parts iron(III) ammonium citrate and two parts potassium ferricyanide in twenty-five parts of water and drying the paper in the dark.
c) Students can be encouraged to overcome difficulties by pooling their ideas and improvising to overcome problems, for example, covering windows with foil emergency blankets to darken a room.
d) Equipment such as trays and safelights can be borrowed, if necessary, from people whose hobby is photography.
e) Items such as plastic gardening flats (without drain holes) can be used as baths for processing solutions.
f) Students should be encouraged to conserve materials by storing solutions in amber glass bottles for reuse.
g) Students can be encouraged to suggest items that might be made into pinhole cameras, such as shoe boxes, juice tins, or cardboard cartons.
h) The use of different light sources can be discussed. Students can achieve the best results by using sunlight or overhead projectors to expose photograms and contact prints and by working outside when taking pictures.
i) The use of showcases and notice boards to display student work encourages good effort and rewards students' attempts.
j) The following are examples of new topics and units that can be developed from the topics in this unit:

| Topics in This Unit | Additional Topics or Units |
|---|---|
| Light-sensitive papers | Light and colour |
| The pinhole camera | Optics |
| The simple camera | Microphotography |
| Developing film | Chemical reactions<br>Photography as art<br>Photography in employment |
| The eye as a camera | Human biology<br>The eyes of animals |

Optional Unit 6

# Locally Designed Units (LDUs)

*Time: About 20 hours each*

This unit is the same for the Grade 12 basic-level science course as optional unit 6, "Locally Designed Units", is for the Grade 11 basic-level course (see page 28). A different set of topics from those selected in a previous grade should, of course, be chosen for this course.

# Appendixes

**Appendixes**

A. Science Courses and Their Course Codes
B. The Table of Contents of Part 1

Appendix A

# Science Courses and Their Course Codes

The secondary school guideline courses in science authorized under this document have the following course codes:

| | |
|---|---|
| Science, Grade 9, Basic Level | SNC1B |
| Science, Grade 9, General Level | SNC1G |
| Science, Grade 9, Advanced Level | SNC1A |
| Science, Grade 10, Basic Level | SNC2B |
| Environmental Science, Grade 10, General Level | SEN2G |
| Science, Grade 10, General Level | SNC2G |
| Environmental Science, Grade 10, Advanced Level | SEN2A |
| Science, Grade 10, Advanced Level | SNC2A |
| Science, Grade 11, Basic Level | SNC3B |
| Applied Biology, Grade 11, General Level | SBA3G |
| Applied Chemistry, Grade 11, General Level | SCA3G |
| Environmental Science, Grade 11, General Level | SEN3G |
| Biology, Grade 11, Advanced Level | SBI3A |
| Chemistry, Grade 11, Advanced Level | SCH3A |
| Science, Grade 12, Basic Level | SNC4B |
| Environmental Science, Grade 12, General Level | SEN4G |
| Geology, Grade 12, General Level | SGE4G |
| Applied Physics, Grade 12, General Level | SPA4G |
| Environmental Science, Grade 12, Advanced Level | SEN4A |
| Geology, Grade 12, Advanced Level | SGE4A |
| Physics, Grade 12, Advanced Level | SPH4A |
| Technological Science, Grade 12, General Level | STE4G |
| Biology, OAC | SBI0A |
| Chemistry, OAC | SCH0A |
| Physics, OAC | SPH0A |
| Science in Society, OAC | SSO0A |

The following general rules govern science course codes:

- All science course codes begin with an **S**.
- **SNC** identifies a course that has only the name "Science".
- Where one word other than "Science" describes the course, the first two letters of that word follow the **S** (e.g., **SBI** means "Science, Biology" or simply "Biology"; **SEN** means "Science, Environmental" or "Environmental Science").
- Where two words other than "Science" describe the course, the initial letters of those words are used (e.g., **SCA** means "Science, Chemistry Applied" or simply "Applied Chemistry").
- The fourth character in the course code, **1**, **2**, **3**, **4**, or **0**, represents Grade 9, 10, 11, 12, or an OAC respectively.
- The fifth character represents the level of difficulty: **B** for basic, **G** for general, or **A** for advanced.

For further information on course codes, refer to the *Manual for the Common Course Code* (Toronto: Ministry of Education, Ontario, 1986).

Appendix B

# The Table of Contents of Part 1

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  Guideline Courses
  Superseded Guidelines

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3. The Aims of the Science Curriculum
   - 3.1 The Aims
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   - 3.3 Scientific Literacy
   - 3.4 Curriculum Emphases – Blending Curriculum Aims With Content

## B. Science Program Framework

4. Science Courses
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   - 4.2 Levels of Difficulty: Basic, General, and Advanced
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   - 4.4 Units of Study Within Each Course
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   - 5.3 Teaching Policy for All Science Units
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   - 5.5 Locally Designed Units
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   - 9.3 Animal Care in Science Courses
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10. Values in Science Education
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## Appendixes

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B. Physical Quantities
C. Metric Editorial Practice
D. Some Poisonous Plants
E. Some OAIP Instrument Types and Learning Domains

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